Space Missions with Solar-Terrestrial Instrumentation*

ACE Advanced Composition Explorer

Agency: NASA (United States)

Website: http://www.srl.caltech.edu/ACE/

Goal: To determine and compare the isotopic and elemental composition of several distinct samples of matter, including the solar corona, the interplanetary medium, the local interstellar medium, and Galactic matter.

To investigate the origin and evolution of solar and galactic matter:
- Elemental and isotopic composition of matter.
- Origin of the elements and subsequent evolutionary processing.
- Formation of the solar corona and acceleration of the solar wind.
- Particle acceleration and transport in nature.

Measurements: The scientific instruments on ACE provide:

Comprehensive and coordinated composition determinations:
- Elemental.
- Isotopic.
- Ionic charge state.

Observations spanning broad dynamic range**:**
- Solar wind to galactic cosmic ray energies (~100 eV/nucleon to ~500 MeV/nucleon).
- Hydrogen to Zinc (Z = 1 to 30).
- Solar active and solar quiet periods.

Solar wind density, velocity, and magnetic field data in real time.

Orbit: Halo orbit at Earth-Sun L1 position.

Status: Operational. Launched August 25, 1997. Current NASA plan funds operations until at least 2007. sufficient fuel on board to last until about 2019.

ACE+

Agency: Danish Meteorological Institute (Denmark)

Websites: http://www.dmi.dk/eng/f+u/index.html
http://ilws.gsfc.nasa.gov/ILWS_Nice_Minutes_final.pdf

Goal: Conduct atmosphere-ionosphere profliling for weather prediction and climate studies.

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* ***Updated: February 7, 2004***

Comments and suggestions concerning information in this table should be sent to dsibeck@hq.nasa.gov with a copy to gwithbro@gmu.edu

Measurements:
Earth Science: Use L-band GPS/GALILEO precison receiver and X/K-band LEO-LEO precison transmitter and receiver to enable intersatellite signals for conducting atmospheric profiling (density, temperature, and humidity).

Geospace Science: Obtain electron density profiles and electron densities in the E region, E and F region scintillations, and information on gravity waves.

Orbits: Earth polar orbit in two planes; in each plane counter-rotating orbits with 2 satellites at altitudes of 650 and 850 km to optimize spatial distribution of occultation.

Status: Under study. Phase A study on merging ACE+ and SWARM to be completed by end of 2003.

ACRIMSAT/ACRIM3

Agency: NASA (United States)

Websites: http://acrim.jpl.nasa.gov/
http://www.acrim.com/
http://eospso.gsfc.nasa.gov/eos_homepage/mission_profiles/index.php

Goal: The purpose of the Earth Observing System/Active Cavity Radiometer Irradiance Monitor (EOS ACRIM) III Experiment is to monitor the Total Solar Irradiance (TSI) with maximum precision and provide an important link in the long term TSI database by monitoring TSI during the solar maximum of solar cycle 23.

Science Objectives:
- Extend the TSI database accumulated by Nimbus7/ERB, SMM/ACRIM I, ERBS, UARS/ACRIM II, SOHO/VIRGO
- Contribute data to the U.S. Global Change Research Program to understand solar influences on climate

Measurements: Measure the integrated solar energy output from 0.2 to 2 microns.

Orbit: Perigee 683 km, apogee 724 km, inclination 98.3 degrees.

Status: Launched December 21, 1999.

AIM Aeronomy of Ice in the Mesosphere

Agency: NASA (United States)

Websites: http://www.hamptonu.edu/science/physics/CAS/AIM/aim.html
http://fpd.gsfc.nasa.gov/410/index.html

Goal: To measure:
- Why do Polar Mesospheric Clouds (PMCs) form, and why do they vary?
- What is the chemical, thermal and dynamical environment in which they form?
- What is the connection between these clouds and the meteorology of the polar mesosphere

Measurements: Nearly simultaneously polar mesopheric cloud abundances, polar mesopheric cloud spatial distributions, cloud particle size distributions, gravity wave activity, cosmic dust influx to the atmosphere needed to study the role of these particles as nucleation sites and precise, vertical profile measurements of temperature, H_2O, OH, CH_4, O_3, CO_2, NO, and aerosols.

Orbit: Circular 550 km, sun-synchronous, noon orbit.

Status: In development. Launch planned for September 2006.

A-IM Atmosphere-Ionosphere Missions

Agency: Swedish Institute of Space Physics (Sweden).

Websites: http://www.physics.irfu.se/Nanny/AIMelaborate.pdf
http://www.irf.se/
http://ilws.gsfc.nasa.gov/ILWS_Nice_Minutes_final.pdf

Goal: Series of advanced low-altitude multi-satellite missions for correlated studies of electromagnetic radiation phenomena and effects, from DC, via radio to optical, X-ray or even gamma-ray, together with basic gas and plasma dynamics in the upper atmosphere/lower ionosphere.

Status: Under study.

Auroral Quartet

Agencies: Alfven Laboratory, Swedish Institute of Space Physics, Danish Space Research Institute (Denmark, Sweden)

Website: http://ilws.gsfc.nasa.gov/ILWS_Nice_Minutes_final.pdf

Goal: Study dynamic and multiscale plasma above the auroral ionosphere out to 1 Earth radius using four satellites.

Status: Under study. Study results are mature.

Bepi Columbo

Agencies: ESA (Europe)**,** ISAS (Japan)

Website: http://sci.esa.int/home/bepicolombo/index.cfm

Goal: Address scientific questions:

- Why is Mercury's density so high?
- What is the origin of Mercury's magnetic field?
- How has Mercury evolved geologically?
- Is there water ice in the polar regions?
- What are the constituents of Mercury's exosphere?
- How does the planetary magnetic field interact with the solar wind in the absence of any ionosphere?
- Can we take advantage of the Sun's proximity to test general relativity with improved accuracy?

Measurements: The mission will consist of two spacecraft, the Mercury Planetary Orbiter (MPO) and the Mercury Magnetospheric Orbiter (MMO), that will go into orbit around the planet and a small lander (called the Mercury Surface Element, or MSE) may also be included. The MPO will study the surface and internal composition of the planet, and the MMO will study Mercury's magnetosphere. The lander would determine the chemical composition and physical properties of the surface. MPO will provide:

- Surface imaging in visible and near-infrared at medium-high resolution
- Surface imaging in visible and near-infrared for complete topography at low resolution
- Mineralogy and observation of absorption bands in near and thermal infrared
- Exospheric composition and morphology - UV photometry, surface mapping
- Elemental mapping / composition of surface layer
- Determination of the chemical composition of the surface, including volatiles in the upper 30 cm layer

- Chemical composition variations. Search for water-ice deposits
- Radio science, range and range-rate measurements
- Global mapping of Mercury gravity field
- Topographic mapping with laser altimeter

MMO will provide:

- Magnetic field mapping Ambient plasma composition and energy distribution
- 3D electron energy distribution
- Survey of magnetospheric waves, detection of radio emission sources, solar activity monitoring
- Low energy plasma distribution in magnetosphere
- Energetic magnetospheric electrons and ions
- Preliminary mapping of the surface

The Surface Element concept includes a camera, a seismometer, an alpha-X-ray detector for chemical elements, and a package to assess the temperature, heat capacity, density and hardness of Mercury's 'soil'.

Orbits:
MMO: Orbit is polar and the period of 9.3 hours is a multiple of that of the planetary orbiter. The line of apsides lies in the equatorial plane, and the pericentre and apocentre cover the altitude range 400 - 12,000 km, which makes it possible to explore the magnetotail up to planetocentric distances of almost six planetary radii.
MPO: Polar orbit to ensure complete coverage of the planet. Pericentre altitude of 400 km, apocentre altitude of 1500 km, and orbital period of 2.3 hours will provide an adequate shift of the ground track between successive orbits.

Status: Selected for development. Launches planned for 2011.

CHAMP (**CHA**llenging **M**inisatellite **P**ayload)

Agency: GeoForschungsZentrum Potsdam (GFZ Potsdam, Germany)

Website: http://op.gfz-potsdam.de/champ/index_CHAMP.html

Goals: The three primary science objectives are to provide:

- Highly precise global long-wavelength features of the static Earth gravity field and the temporal variation of this field.
- With unprecedented accuracy global estimates of the main and crustal magnetic field of the Earth and the space/time variablity of these field components
- With good global distribution a large number of GPS signal refraction data caused by the atmosphere and ionosphere, which can be converted into temperature, water vapor and electron content.

Thus, contributing to the following Earth system components:

- *Geosphere:* investigation of the structure and dynamics of the solid Earth from the core along the mantle to the crust, and investigation of interactions with the ocean and atmosphere.
- *Hydrosphere:* more accurate monitoring of ocean circulation, global sea level changes and short-term changes in the global water balance as well as interactions with weather and climate.
- *Atmosphere:* global sounding of the vertical layers of the neutral and ionized gas shell of the Earth and relationship with weather on Earth and space weather.

Measurements: Instrumentation consists of highly precise, multifunctional and complementary payload elements (magnetometer, accelerometer, star sensor, GPS receiver, laser retro reflector, ion drift meter)

Orbit: Almost circular, near polar (i = 87°) orbit with an initial altitude of 454 km.

Status: Operational. Launched July 15, 2000 with design lifetime of 5 years.

CINDI/CNOFS Coupled Ion Neutral Dynamics Investigation /Communication and Navigation Outage Forecast System

Agency: NASA, DOD (United States)

Websites: http://129.110.7.63/heelis/cindi.html
Http://www.specastro.com/../../PDFs/CNOFS-Web.pdf
Http://fpd.gsfc.nasa.gov/410/index.html

Goals:
CINDI: Experiment on CNOFS satellite to investigate the physical connections between the ion and neutral gases that lead to and promote the growth of equatorial plasma structure. Address questions:

- What are the relationships between the behavior of F-region neutral winds and the daily variability of ExB drifts ?
- How do F-region neutral winds and ExB drifts influence the evolution of irregularities ?

CNOFS: Mission to determine when and where regions of ionospheric irregularities will appear and what the impact of those irregularities on radio communications will be. Conduct two-year demonstration program that utilizes in-situ measurements from a satellite to drive a forecast model in real time.

Measurements: The CINDI instruments provide measurements of the neutral wind velocity vector and the ion drift velocity vector. CINDI is one of seven instruments on the C/NOFS) satellite. C/NOFS will carry three types of sensors: 1)*in-situ* ionospheric plasma property instruments, 2) remote electron density GPS occultation sensor and imaging UV spectrographs and 3) radio beacon and receiver for ionospheric scintillation detection.

Orbit: 400 by 710 km altitude, 13 degree inclination.

Status: In development. Launch planned for January 2005.

CLUSTER

Agencies: ESA (Europe), NASA (United States)

Websites: http://sci.esa.int/home/clusterii/index.cfm
http://sci.esa.int/cluster/
http://sci.esa.int/home/cluster/index.cfm
http://ilws.gsfc.nasa.gov/ESA_Nice.pdf

Goal: Cluster's main goal is to study the small-scale plasma structures in space and time in the key plasma regions:

- Solar wind and bow shock.
- Magnetopause.
- Polar cusp.
- Magnetotail.
- Auroral zone.

Measurements: The four Cluster spacecraft carry identical sets of 11 scientific instruments designed to provide the first detailed, three-dimensional picture of what happens within different regions of the magnetosphere. The instruments measure electric and magnetic fields; waves; plasma convection; low and medium electron velocities and directions; magnetospheric and solar wind ion composition, mass, and distribution functions; energic electrons (20 - 400 keV) and ions (40 -4000 keV for hydrogen, 10 keV/nuc - 4000 keV for heavier ions).

Orbits: The four Cluster spacecraft are in nearly identical, highly eccentric polar orbits, apogees of about 20 Earth radii and perigees of 4 Earth radii.

Status: Operational. Spacecraft launched July 12, 2000 and August 9, 2000. Current plan funds operations until the end of 2005. The first attempt to launch four Cluster spacecraft was a unsuccessful due to a failure of the launch vehicle.

CORONAS-F Complex Orbital Near-Earth Observations of the Solar Activity

Agency: IZMIRAN (Russia)

Websites: http://ilws.gsfc.nasa.gov/russia_cospar.pdf
http://coronas.izmiran.rssi.ru

Goals:

- The seismologic study of the solar interior based on observed global oscillations.
- The study of energy transport from the solar interior to the surface, its build-up in the upper atmoshere and subsequent release in non-stationary solar events.
- The study of major dynamic phenomena of the active Sun (sunspots, flares, plasma ejections).
- The study of cosmic rays, accelerated in solar flares, as well as other active phenomena, their escape, interplanetary propagation, and geophysical effect.

Measurements: Instrumentation includes multichannel solar photometer, full Sun XUV spectroscopy imaging, X-ray spectrometers, X-ray photometer, gamma-ray spectrometer, UV radiometer and spectrophotometer, and solar cosmic ray complex (cosmic ray monitor, spectrometer for energy and ion chemical composition, solar neutron and gamma-ray spectrometer).

Orbit: Altitude 500 by 548 km, inclination 82.5 degrees.

Status: Operational. Launched July 31, 2001

CORONAS-PHOTON

Agency: Moscow Engineering Physics Institute (Russia)

Websites: http://ilws.gsfc.nasa.gov/Russia_Nice.pdf
http://astro.mephi.ru (in Russian)

Goals:

- Study of the dynamics of the energy spectra of hard electromagnetic radiation from EUV to 2000 MeV.
- Nuclear gamma-lines spectroscopy of solar active regions.
- Detection of solar neutronas with energies higher than 5 MeV.
- Measurements of polarization and rapid variability of hard x-ray emission during flares.
- Monitoring solar extreme ultraviolet (EUV), soft and hard X-ray emissions.
- Detection of the fluxes of electrons, protons and nuclei at the satellite orbit.
- Monitoring the Earth upper atmosphere by occultation measurements of EUV and soft X-rays radiated by quiet Sun.

Measurements: Gamma-ray spectroscopy 0.3 - 2000 MeV; neutron measurements 20-300 MeV; hard X-ray spectroscopy 15-150 keV, 100 - 2000 keV; hard X-ray polarization 20 - 150 keV, X- and Gama-ray spectroscopy 0.15 - 5 MeV, soft X-ray data 1 - 10 keV; hard X-ray monitoring with sub-msec temporal resolution 20 - 500 keV; hard X-ray and gamma-ray spectroscopy with high temporal resolution 0.1 - 12 MeV, full disk imaging in EUV and soft x-rays, EUV and soft x-ray monitoring in various bands (e.g. $\lambda < 10$ nm, He II, He I, OII-OIV, H Lyman-alpha lines); energetic particle analyzer: electrons (0.2 - 2 MeV), protons (1 - 150 MeV), alphas (1.5 - 50 MeV/nucleon), nuclei ($Z < 26$, 2 - 50 MeV/nucleon); energetic particle telescope: electrons (0.15 - 10 MeV), protons (4 - 62 MeV), alphas (15.5 - 245.5 MeV).

Orbit: Circular with 500 km altitude, inclination 82.5 degrees.

Status: In development. Launch planned for 2006.

COSMIC/ROCSAT-3 Constellation Observing System for Meteorology, Ionosphere and Climate

Agency: NSPO (Taiwan)

Websites: http://www.nspo.gov.tw/e50/home/
http://www.cosmic.ucar.edu/

Goals: *Ionospheric Physics:* Carry out ionospheric research by using the ionospheric electron density profile deduced from the observed atmospheric refractivity. Topics include (1) ionospheric global modeling, (2) ionospheric global modeling study, (3) investigation of space weather, (4) global ionospheric response to the solar disturbance and geomagnetic storm.

Earth Science: The orbit data can be used for study of Earth's global gravity field and its variation in the atmosphere-hydrosphere-solid earth system. The water vapor content and temperature distributions of the lower atmosphere derived from COSMIC data will provide a valuable contribution to the studies of East Asian Monsoon and short-term climate variability.

Measurements: Multi-point measurements of GPS signals using a constellation of 6 LEO micro-satellites. Each micro-satellite carries a GPS receiver to measure the propagation time of a radio signal from a GPS satellite to a ROCSAT-3/COSMIC satellite. When the radio signal passes obliquely through Earth's atmosphere, the satellite will measure the amount of radio occultation, which will be used to infer the density, temperature, and moisture of the atmosphere at various heights.

Orbit: 700-800km altitude, circular, inclination 72 degree.

Status: In development. Launch planned for fall 2005 for 2 years operations, design life > 5 years.

DEMETER

Agency: CNES (France)

Website: http://smsc.cnes.fr/DEMETER/

Goals:

- Study the ionospheric disturbances related to seismic activity
- Study the ionospheric disturbances related to human activity
- Study the pre- and post-seismic effects in the ionosphere
- Contribute to understand the mechanisms generating those disturbances
- Give global information on the Earth's electromagnetic environment at the satellite altitude.

Measurements: Total plasma density (electrons and ions), electronic temperature, measure of the satellite potential, direction of ion flow, total plasma density and ion composition, ion temperature, plasma global speed, precipitation of energetic electrons (30keV – 1MeV).

Orbit: quasi-polar, altitude 800km.

Status: In development with launch planned for 2004.

DMSP Defense Meteorological Satellite Program

Agency: DOD (United States)

Websites: http://dmsp.ngdc.noaa.gov/dmsp.html http://www.ipo.noaa.gov/About/sat_evolu.html

Goal: Monitor the meteorological, oceanographic, and solar-terrestrial physics (geospace) environments.

Measurements:
Earth Science: Provides various atmospheric, oceanographic, and land parameters on a global basis.

Geospace: Precipitating electron and ion spectrometer measures energy spectrum of the low energy particles that cause the aurora and other high latitude phenomena. The data set consists of electron and ion particle fluxes between 30 eV and 30 KeV recorded every second, satellite ephemeris and magnetic coordinates where the particles are likely to be absorbed by the atmosphere. The detectors also record high energy ions that penetrate both the satellite and the instrument (most noticeable in the South Atlantic Anomaly and at the "horns" of the radiation belts). The two low energy detectors consist of 10 channels centered at 34, 49, 71, 101, 150, 218, 320, 460, 670, and 960 eV. The high energy detector measures particles in 10 channels centered at 1.0, 1.4, 2.1, 3.0, 4.4, 6.5, 9.5, 14.0, 20.5 and 29.5 keV. The ion scintillation monitor measures ambient electron density and temperatures, the ambient ion density, and the average ion temperature and molecular weight at the DMSP orbital altitude. The magnetometer measures geomagnetic fluctuations

associated with geophysical phenomena (i.e., ionospheric currents flowing at high latitudes). Data available via NOAA (http://dmsp.ngdc.noaa.gov/html/availability.html).

Orbit: Polar at 830 km, Sun-synchronous, 99 degree inclination, period 101 min.

0530 or 0730 local equatorial crossing times depending on spacecraft. NPOESS will cover 0730 crossing time starting in the year 2009 and 0530 crossing time in the year 2013.

Status: Operational.
F13 Launched March 24, 1995.
F14 Launched April 10, 1997.
F15 Launched December 12, 1999.
F16 Launched October 18, 2003.
F17 Launch planned for 2004.
F18 Launch planned for 2006.
F19 Launch planned for 2008.
F20 Launch planned for 2010.

Double Star

Agencies: CNSA (China), ESA (Europe)

Website: http://sci.esa.int/home/doublestar/index.cfm

Goals:
- Study the magnetic reconnection at the magnetopause and in the magnetotail
- Understand and locate the trigger mechanism for magnetospheric storms and substorms
- Study physical processes such as particle acceleration, diffusion, injection, and up-flowing ions during storms
- Study temporal variations of field-aligned currents and the coupling between tail current and auroral current.

Measurements: The equatorial satellite (TC-1) will detect the physical processes of geospace storms in the near-Earth magnetotail and the energy transfer from the solar wind to the magnetosphere. The polar satellite (TC-2) will detect energy transfer from solar wind to magnetosphere via dayside magnetopause. The polar satellite will detect energy transfer from solar wind and near-earth magnetotail to polar ionosphere and upper atmosphere, as well as to detect ionised-particle transfer from ionosphere to magnetosphere. Instruments include: Active Spacecraft Control (ASPOC), one instrument (TC-1 only), Hot Ion Analyser (HIA), part of the CIS instrument on Cluster, one instrument (DSP-1 only), Fluxgate Magnetometer (FGM), two instruments (TC-1 and 2), Plasma Electron and

Current Experiment (PEACE), two instruments (TC-1 and 2), Spatio-Temporal Analysis of Field Fluctuations (STAFF), one instrument (TC-1 only).

Orbits: Equatorial satellite (530 x 63,780 km, inclination 28.5 °) and polar satellite (700 x 39,000 kim, inclination 90 °).

Status: In development. The equatorial satellite TC-1 was successfully launched December 29, 2003. Launch of TC-2 is scheduled for June 2004. Planned operational lifetime of 18 months.

Obstanovka (ENVIRONMENT) Experiment on International Space Station

Countries: Russia, Ukraine, Poland, Bulgaria, Unitied Kingdom, Hungary.

Websites: http://ilws.gsfc.nasa.gov/Ukraine_Nice.pdf
http://ilws.gsfc.nasa.gov/Russia_Nice.pdf

Goal: Monitor electromagnetic state of the ionosphere.

Measurements: Magnetic and electric waves measurements; magnetic field vector; Langmuir probe; plasma wave spectrometer; electron correlator.

Orbit: International Space Station Orbit.

Status: Under development with launch planned for 2005.

EGPM

Country: Denmark.

Website: http://ilws.gsfc.nasa.gov/ILWS_Nice_Minutes_final.pdf

Status: Under study.

EPOP Enhanced Polar Outflow Probe

Agency: CSA (Canada)

Websites: http://ilws.gsfc.nasa.gov/csa_cospar.pdf
http://ilws.gsfc.nasa.gov/Canada_Nice_03.pdf
http://ilws.gsfc.nasa.gov/csa_kickoff.pdf

Goal: Study acceleration of ion outflow in upper atmosphere and its effects on neutrals. Obtain ionospheric tomography using space-ground radio propagation.

Scientific Questions: How are thermal ionospheric ions and electrons accelerated by ionospheric waves? How strongly do accelerated ions drag neutrals upward? What is the tomography of the ionosphere where the acceleration takes place? The ionosphere is a source of magnetospheric particles. New 'collisionless physics', if outflowing ions were found to interact strongly with neutrals.

Measurements: Ion distribution between 1 and 100 eV and 1-40 amu @ 10 ms resolution. Electron distribution between 2 and 200 eV @ 10 ms resolution. Characterize local electromagnetic waves in the frequency range 100-30,000 Hz. Neutral mass and velocity spectrometer. Fast auroral imager in near-IR band 650 - 850 nm (10 images/sec) and monochromatic emission ato 630 nm line (1 image/min). Magnetometer. Radio channel at HF (3-30 MHz), VLF, and UHF frequencies. GPS receiver and GHz onboard beacon.

Orbit: 300 x 1500 km elliptical with 70 degree inclination.

Status: Under study. Launch planned for 2006.

EQUARS Environmental Atmospheric Research Satellite

Agency: INPE (Brazil)

Websites: http://www.laser.inpe.br/equars/mission.htm
http://ilws.gsfc.nasa.gov/ILWS_Nice_Minutes_final.pdf

Goal: To understand atmospheric coupling between dynamical, electrical, photochemical and ionospheric processes, and to apply the data to atmospheric, space weather and climate studies.

Topics to be Investigated: Equatorial Atmosphere monitoring: water vapor profile, cloud convection and lightning (Troposphere); temperature variability (Stratosphere); wave propagation and temperature variability (Mesosphere); generation and propagation of plasma bubbles (Ionosphere).

Measurements: Water vapor, temperature, total electron content (TEC) with GPS receiver; sprite imager for lightning and sprites; airglow and gravity waves; mesopause temperature; airglow OI 5577, OI 6300, OH; plasma density; electron temperature; energetic particle flux.

Orbit: Equatorial, Altitude 700 km , Inclination 20 degrees.

Status: To be developed with launch planned for July 2007.

FAST Fast Auroral Snapshot Explorer

Agency: NASA (United States)

Websites: http://sprg.ssl.berkeley.edu/fast/
http://sunland.gsfc.nasa.gov/smex/fast/

Goal: To study the microphysics of space plasma and the accelerated particles that cause the aurora.

Measurements: FAST flies high into the charged particle environment of the aurora to measure the electric and magnetic fields, plasma waves, energetic electrons and ions, ion mass composition, and thermal plasma density and temperature. The instrument set consists of sixteen electrostatic analyzers, four electric field langmuir probes suspended on 30 m wire booms, two electric field langmuir probes on 3 m extendible booms, searchcoil and fluxgate magnetometers and a time-of-flight mass spectrometer.

Orbit: FAST is in a 351 x 4175 km orbit with an 83° inclination.

Status: Operational. Llaunched August 21, 1996. Current NASA plan funds operations until 2006.

FedSat

Agency: CRCSS (Australia)

Websites: http://www.crcss.csiro.au/overview.htm#CRCSS_overview
Http://www.nasda.go.jp/projects/rockets/h2a/documents/f4/sheet/h2af4_11_e.html

Goal: GPS studies into orbit determination and the ionosphere, to study the magnetosphere, to conduct Ka/UHF band communication experiments, and reconfigurable high-performance computers experiments.

Measurements: GPS receiver for accurate measurement of the satellite's position, studying GPS multipath errors, providing timing data for other FedSat payloads, and space-science studies of the ionosphere (dynamics, 3D imaging). Magnetometer for very sensitive and rapid-sampling measurements of the strength of the Earth's magnetic field. Also Ka/UHF and computer experiments.

Orbit: Altitude about 800 km, 99 degree inclination, Sun-synchronous.

Status: Launched December 14, 2002

GEC Geospace Electrodynamic Connections

Agency: NASA (United States)

Website: http://stp.gsfc.nasa.gov/missions/gec/gec.htm

Goals:

1. To observe the magnetospheric energy transfer to the ionosphere and thermosphere by making space-time resolved observations in the transfer region.
2. To determine the key processes and their space-time scales for coupling between the ionosphere-thermosphere as magnetospheric energy is dissipated.

Measurements:

Concentrations of all relevant IT constituents, their temperatures and velocities, the local electric and magnetic fields and the energetic particle distributions. The core measurements will be made by *in situ* measuring sensors. To provide a global context to the *in situ* observations (e.g., the flow fields and plasma effects away from the spacecraft) would require remote-sensing detectors. The preliminary spacecraft design includes both in-situ measuring detectors and remote viewing sensors. The spacecraft are 3-axis spin stabilized to avoid compromising the in situ sampling instrument observations. This attitude configuration will allow for the positioning of nadir looking or limb scanning optical devices. The flat, front ram face of the spacecraft will hold the instruments for thermal plasma and neutral gas measurements, which use the ram speed of the spacecraft to efficiently sample the environment. The solar arrays are to be body mounted and electrically conducting, in order to minimize perturbations on the plasma measurements due to spacecraft shadowing and spacecraft electric fields.

Orbits: Initially the satellites will be placed in identical high inclination elliptical parking orbits (~200 km by 2000 km). The spacing between the spacecraft in this pearls-on-a-string configuration will be varied from ~ 10 km to 1/4 of the orbit. This novel variation of the spacecraft separations, using onboard propulsion, will allow unique observations of important ranges of temporal and spatial scales. Each spacecraft, carrying more than 200 kg of propulsion fuel will have the capability of executing more than a dozen weeklong dipping campaigns during the baseline 2 year mission to altitudes below 130 km where the atmosphere effects on plasma processes and spacecraft aerodynamics are prominent. Later in the mission the 4 spacecraft will be maneuvered into different orbit configurations, a petal formation or relative changes in local time which will allow one to resolve vertical and horizontal structures.

Status: To be developed under Solar Terrestrial Probes program. Launch of four identical spacecraft with about 10 instruments deferred until after launch of MMS in 2012.

GENESIS

Agency: NASA (United States)

Website: http://genesismission.jpl.nasa.gov/

Goal: Addresses questions about the materials and processes involved in the origins of the solar system by providing precise knowledge of solar isotopic and elemental compositions, a cornerstone data set around which theories for materials, processes, events, and time scales in the solar nebula are built, and from which theories about the evolution of planets begin.

Measurements: Measures solar composition by collecting solar wind for analysis in terrestrial laboratories. Solar wind ions have velocities in the well-understood ion implantation regime and are quantitatively retained upon striking passive collectors. This was demonstrated by the highly successful Apollo solar wind foil experiments. With 100-times longer exposure and, especially, with purer collector materials, Genesis provides precise solar isotopic compositions and greatly improved solar elemental composition for most of the Periodic Table. The Apollo foils were only sufficiently pure for the study of noble gases. On board solar wind instruments monitor solar wind parameters so that the solar wind collectors can collect separately fast wind from coronal holes (CH) and slow interstream (IS) wind originating in or near coronal streamers, and transient flows produced by eruptions [coronal mass ejections (CME)]. Data from the monitors are transmitted to Earth periodically, the collectors will be returned by a re-entry capsule.

Orbit: Halo orbit at Earth-Sun L1 position for 29 months (until April 2004), followed by 5.3 month return and recovery orbit. Total flight time 37.3 months from launch.

Status: Operational. Launched August 8, 2001. Current NASA plan funds operations until September 2004.

Geostorm

Agency: NOAA (United States)

Goal: To provide 0.5 to 1 hour (or more for sub-L1 orbit) warning of solar wind transients capable of causing geomagnetic storms.

Measurements: Solar wind temperature, density, velocity, and magnetic field.

Orbit: Halo orbit at Earth-Sun L1 or sub-L1 position.

Status: Under study for possible launch in 2009.

Geotail

Agencies: ISAS (Japan), NASA (United States)

Websites: http://www-spof.gsfc.nasa.gov/istp/geotail/
http://www-istp.gsfc.nasa.gov/

Goal: To study the dynamics of the Earth's magnetotail over a wide range of distance, extending from the near-Earth region (8 Earth radii (Re) from the Earth) to the distant tail (about 200 Re). Measure global energy flow and transformation in the magnetotail to increase understanding of fundamental magnetospheric processes, including the physics of the magnetopause, the plasma sheet, and reconnection and neutral line formation (i.e., the mechanisms of input, transport, storage, release and conversion of energy in the magnetotail).

Geotail is an element of the the Global Geospace Science Program (GGS) designed to improve greatly the understanding of the flow of energy, mass and momentum in the solar-terrestrial environment with particular emphasis on "geospace". GGS has as its primary scientific objectives: a) Measure the mass, momentum and energy flow and their time variability throughout the solar wind-magnetosphere- ionosphere system that comprises the geospace environment; b) Improve the understanding of plasma processes that control the collective behavior of various components of geospace and trace their cause and effect relationships through the system; c) Assess the importance to the terrestrial environment of variations in energy input to the atmosphere caused by geospace plasma processes. The other GGS missions are Wind and Polar. Complementary equatorial data are provided by the GOES spacecraft.

Measurements: Electron and ion velocity distribution functions and directions over a wide range of energies; ion composition; temporal variations of electric and magnetic fields; plasma oscillations and waves; electric currents.

Orbit: During the initial two-year phase, the orbit apogee was kept on the night side of the Earth by using the Moon's gravity in a series of double-lunar-swing-by maneuvers that resulted in the spacecraft spending most of its time in the distant magnetotail (maximum apogee about 200 Re) with a period varying from one to four months. In February 1995, phase two was commenced as the apogee was reduced to 30 Re to study the near-Earth magneto-tail processes.

Status: Operational. Launched July 24, 1992.

GOES Geostationary Operational Environmental Satellites

Agency: NOAA (United States)

Websites: http://www.oso.noaa.gov/goes/index.htm http://rsd.gsfc.nasa.gov/goes/text/goes.databook.html
http://www.sec.noaa.gov/sxi/
http://sxi.ngdc.noaa.gov/

Goal: Serve as one of two types of satellites currently making up NOAA's operational weather satellite system monitoring the meteorological, oceanographic, and solar-terrestrial physics (geospace) environments. The geostationary operational environmental satellites (GOES) provide data for short-range warning and "now-casting" and the polar-orbiting satellites (POES) provide data for longer-term forecasting. Both types of satellites are necessary for providing a complete global weather monitoring system.

Measurements:
Earth Science: Provides various atmospheric, oceanographic, and land parameters on a global basis.

Geospace: Energetic particles in geostationary orbit (protons in 7 bands from 0.8 to 500 MeV, logarithmically spaced, and 3 bands from 350 to >700MeV; alphas in 6 bands from 3.2 to 500 MeV, logarithmically spaced, and 2 bands from 2500 to 3400 MeV; electrons in intergral bands with thresholds of 0.55 MeV, 2.0 MeV, and 4.0 MeV).

Solar: X-ray flux (0.5 to 3 Angstroms and 1 to 8 Angstroms), and for GOES-12 and subsequent missions, solar full disk soft x-ray images (SXI instrument) in two bands (6 to 20 Angstroms and 6 to 60 Angstroms with 5 by 5 arcsec pixels). [See http://rsd.gsfc.nasa.gov/goes/text/databook/section05.pdf, http://rsd.gsfc.nasa.gov/goes/text/databook/section06.pdf.]

Orbit: Geostationary (35,800 km).

Status: Two spacecraft are operational at a given time (East and West with several spacecraft in-orbit storage as backups)
GOES-10 Launched April 25, 1997 (West)
GOES-12 Launched July 23, 2002 (East; SXI data from April 1, 2003)
(Backups GOES 8, 9, 11)
GOES-N Launch planned for July 2004
GOES-O Launch planned for April 2007
GOES-P Launch planned for October 2008
GOES-R Launch planned for April 2012

GPS Global Positioning Satellites

Agency: DOD (United States)

Websites: http://tycho.usno.navy.mil/gpscurr.html
http://www.aero.org/publications/GPSPRIMER/
http://igscb.jpl.nasa.gov/
http://www.colorado.edu/geography/gcraft/notes/gps/gps_f.html

Goals:
Positioning: GPS provides specially coded satellite signals that can be processed in a GPS receiver, enabling the receiver to compute position, velocity and time.
Geospace: Measure the space environment.

Measurements:
Positioning Data: Precise GPS satellite position and time data are continuously broadcast by each satellite.
Geospace: Measurements of the GPS radio signals can be used to to obtain profiles of ionospheric electron densities and other geophysical variables such as temperature, pressure, and water vapor in the lower atmosphere. There are also instruments on some GPS satellites designed to make space environmental measurements. Several generations of detectors have been flown. The first set are called BDD for Burst Detector Dosimeter. BDD instruments were flown on one of every six GPS satellites. With 24 GPS satellites in the constellation that means 4 BDD's on orbit. The other 5 out of 6 had an X-ray instrument (flux measurement, not imaging). Several versions of BDD's were flown in which some channels do not reliably discriminate protons from electrons. BDD-1 Dosimeter (4 electron, 4 proton channels, 0.3 MeV to >2 MeV) Flown on NS08 and NS10 (1983 to 1992). BDD-2 Particle Spectrometer 7 electron, 4 proton coincidence channels, 0.25 MeV to >5 MeV. Flown on NS18, NS24, NS28, NS39, & NS33 beginning in 1990. GPS Block IIR Particle Spectrometer (8 electron channels 80 keV to >6 MeV, 8 proton channels 2 to >60 MeV) currently contracted for 21 spacecraft. More recently the Combined X-ray Dosimeter (CXD) combines the X-ray and Dosimeter functions in a single instrument. CXD instruments will eventually fly on all 24 GPS satellites in the constellation. The first CXD was launched in 2001. Thus the space environment component of the constellation will increase from 4 to 24 satellites starting in 2001. How long it will take to get to full 24-satellite coverage depends on how quickly the new GPS satellites are launched. CXD Combined X-Ray sensor and energetic particle dosimeter (13 electron channels 80 keV to >7.6 MeV, 3 proton channels 1.3 MeV to > 54.1 MeV).

Orbit: GPS orbits are 4.2 Re circular with a 55 degree inclination and a 12-hour period. Each satellite provides 4 passes per day through the radiation belts (L>4.2).

Status: Constellation of 24 satellites maintained to provide global precise positioning data. Current status on number of GPS satellites in orbit, type, launch dates, etc. given at http://tycho.usno.navy.mil/gpscurr.html.

GSAT-2 Indian Geostationary Satellite

Agency: Indian Space Research Organisation (India)

Websites: http://www.isro.org/space_science/index.htm
http://www.isro.org/space_science/images/SOXSexperimentFigText.htm
http://www.spacedaily.com/2003/030512090944.4jx97w04.html
email: Prof. Rajmal Jain <rajmal@prl.ernet.in>

Goals: Flight of experimental communications satellite with four piggyback experimental payloads. Solar piggyback instrument to study energy release processes and particle acceleration mechanisms in solar flares.

Measurements: Piggyback instrumentation includes a solar X-ray spectrometer (SOXS) which measures solar flux in two energy bands from 4 keV - 10 MeV and a radio beacon experiment to investigate the ionosphere. SOXS has a low energy detector covering the energy range 4 to 60 keV and a high energy detector covering the energy range 25 keV to 10 MeV. The temporal resolution for X-ray spectra and fixed energy windows is 100ms during solar flares.

Orbit: Geostationary orbit

Status: Successfully launched May 8, 2003.

Heracles

Country: France.

Websites: http://ilws.gsfc.nasa.gov/esa_cospar.pdf

Status: Under study.

IMAGE Imager for Magnetopause-to-Aurora Global Exploration

Agency: NASA (United States)

Website: http://pluto.space.swri.edu/IMAGE/

Goal: Address three key science questions relevant to understanding the geospace environment and its response to the solar wind:

- What are the dominant mechanisms for injecting plasma into the magnetosphere on the time scales of substorms and geomagnetic storms?
- What is the directly driven response of the magnetosphere to changes in the solar wind?
- How and where are magnetospheric plasmas energized, transported, and lost during geomagnetic storms and magnetospheric Substorms?

Measurements: IMAGE employs a variety of imaging techniques: the detection of energetic neutral atom (ENA) emissions (1-500 keV per atomic mass unit) from the ring current, inner plasma sheet, and polar ionospheric outflows; plasmaspheric imaging at extreme ultraviolet (EUV) wavelengths (narrow band images at 121.8 nm and 135.6 nm, wide band from molecular nitrogen at 140-160 nm, geocoronal Lyman alpha at 121.6 nm); radio sounding of the magnetopause and other boundary layers; and imaging of far-ultraviolet (FUV) auroral emissions from singly ionized helium at 30.4 nm.

Orbit: IMAGE is in an elliptical polar orbit with an apogee altitude of 7.2 Earth radii 46,000 km. The location of the apogee changes during the course of the two-year mission, both in latitude and, because of the Earth's revolution about the Sun, in local time so as to permit study of magnetosphere from different perspectives.

Status: Operational. Launched March 25, 2000. Current NASA plan funds operations until 2007.

INTERBALL-PROGNOZ

Agencies: IKI, NPO Lavochkin (Russia); Brazil, Ukraninian Space Research Institute, GKB Yuzhnoe (Ukraine)

Websites: http://ilws.gsfc.nasa.gov/russia_cospar.pdf
http://ilws.gsfc.nasa.gov/ILWS_Nice_Minutes_final.pdf
http://www.iki.rssi.ru/interballp

Goals:
Tests of space weather-related methods and instrumentation. Monitoring and investigating solar input, outer magnetosphere, ionosphere and magnetosphere-ionosphere interactions.

Measurements: Magnetic field, solar radiation, solar wind, plasma and energetic particle measurements with interball-3 spacecraft and ionospheric thermal plasma and precipitation, radio sounding, and driftmeter measurements with ionospheric spacecraft.

Orbits: Interball-3 initially at Earth-Sun L1 halo orbit for 6 months followed by 3-4 years in outer magnetosphere in elliptical orbit with apogee of 400,000 km providing measurements far downstream in geotail. Ionospheric spacecraft (3 microsats) in Sun-synchronous dawn-dusk circular orbit with altitude of 600-700 km.

Status: Under investigation for launch in 2006-2007.

Interhelioprobe

Agencies: IZMIRAN, IKI, NPO Lavochkin (Russia)

Websites: http://ilws.gsfc.nasa.gov/russia_cospar.pdf
http://ilws.gsfc.nasa.gov/ILWS_Nice_Minutes_final.pdf

Goals:
- To investigate mechanisms of coronal heaing and colar wind.
- To investigate the fine structure and dynamics of the solar atmosphere in polar and equatorial regions.
- To determine the origin of the most powereul solar activity phenomena (solar flares and CME's).
- To investigate generation and propagation of solar energetic particles.

Measurements:
Solar instruments: optical telescope, magnetograph, x-ray imager/spectromenter, coronagraph.

Heliospheric instruments: solar wind ion and electron analyzer, solar wind plasma and dust analyzer, magnetic wave complex, magnetometer, energetic particle telescope, neutron detector, radio spectrometer, electron gun.

Orbits: Heliocentric with solar passes inside orbit of Mercury.

Status: Under investigation for launch in 2007-2008.

Ionosphere/Thermosphere Storm Probes

Agency: NASA (United States)

Websites: http://lws.gsfc.nasa.gov/docs/Geospace/TownHall_2002AGU.pdf
http://lws.gsfc.nasa.gov/geospace.htm

Goal: Characterize and understand mid-latitude ionospheric variability and irregularities that affect communications, navigation and radar systems.

Scientific questions: How does the I-T system vary in response to changing solar EUV? How does the mid- and low-latitude I-T system respond to positive-phase storms?

Measurements: Both spacecraft: Plasma density, drift, and density fluctuations. Thermospheric wind, density, and composition. Ionospheric (N_e) altitude profiles. In-orbit scintillations. Complementary missions: EUV spectral flux on SDO, I-T mid-latitude imager package at GEO: FUV for O/N_2 and N_e^2. Plus, if feasible, auroral electron precipitation, currents (**B**), AC electric fields.

Orbit: Twin spacecraft at 60^o inclination, 450 km altitude orbits separated by 10^o - 20^o longitude.

Status: To be developed under Living With a Star program, launch planned for 2010 for 3 year mission with optional 2 year extension.

KOMPSAT-1 Korea Multi-Purpose Satellite 1

Agency: KARI (Korea)

Websites: http://www.kari.re.kr/new_html/English_version/E_index.htm
http://www.astronautix.com/craft/kompsat.htm

Goal: Provide cartography data for stereo imaging of Korean peninsula for mapping land use and planning, ocean observations to estimate global marine resources and environment, and space environmental data in KOPMSAT-1 orbit.

Measurements:
Earth science/Earth mapping: Optical Camera provides 7-meter resolution; Ocean Scanning Multi-spectral Imager provides multi-spectral image data in 6 bands.

Geospace science: Space Physics Sensor measures high energy cosmic particles, ionosphere irregularities, and the densities and temperature of electrons.

Orbit: *Perigee* 690 km, a*pogee* 722 km, *inclination* 98.3 deg.

Status: Operational. Launched December 21, 1999.

KOMPSAT-2 Korea Multi-Purpose Satellite 2

Agency: KARI (Korea)

Websites: http://www.kari.re.kr/new_html/English_version/E_index.htm
http://www.astronautix.com/craft/kompsat2.htm

Goal: Observation of natural resources, digital map-making and atmospheric research, and high resolution imaging. No information available at above sources re possible geospace instrumentation.

Measurements: *Earth Science:* Multi-spectral imaging. *Geospace:* ?

Orbit: Altitude 685 km.

Status: In development with launch planned for April 2004.

L5 Mission

Agency: Communications Research Laboratory (Japan)

Websites: http://ilws.gsfc.nasa.gov/crl_kickoff.pdf
http://ilws.gsfc.nasa.gov/ILWS_Nice_Minutes_final.pdf

Goals: Side view observation of Coronal Mass Ejections (CME) propagating toward Earth. Monitoring and 3D observations of harardous sunspot groups. Advance detection and measurement of high speed streams.

Measurements: *Instruments:* Wide field coronal imager, high resolution coronal image, solar wind plasma anaylzer, high energy particle instruments, magnetometer, plasma wave detector.

Orbit: Heliospheric at L5 position.

Status: Under study. Launch target is next solar maximum (2008-2013). Mission lifetime: 4 years.

Maxwell

Country: United Kingdom

Websites: http://ilws.gsfc.nasa.gov/esa_cospar.pdf
http://www.eiscat.rl.ac.uk/~ian/maxwell_proposal.htm

Goal: Utilize a four spacecraft mission to study near-Earth space.

Objectives:

- Study the physics of the auroral oval and the cusp in three dimensions and on a range of temporal and spatial scales.
- Make three-dimensional measurements of auroral structures, discriminating between the many theories of auroral acceleration and making clear the mechanisms which energise and eject ionospheric plasma into the magnetosphere.
- Remotely sense magnetic reconnection in the magnetopause current layer using a unique combination of multi-point sampling and remote sensing in the interior cusp.
- Application of the same techniques on the nightside to remotely sense reconnection in the cross-tail current layer provide an opportunity to finally resolve the outstanding controversies over the substorm onset mechanism.
- The combination of multipoint measurements, remote sensing and conjunction for long periods with ground based facilities will enable unambiguously mapping of magnetospheric signatures along open or closed field lines to their ionospheric footprints.
- The high resolution particle time series and wave measurements resulting from the long residence times in various magnetospheric regions will be of great importance in the investigation of turbulence and non-linear effects in space plasmas.
- These advances are essential building blocks for the understanding of space weather effects, and are thus highly timely.

Measurements: All satellites carry a core payload comprising a low energy ion spectrometer, electron spectrometer, and magnetometer, so as to perform multi-point measurements on the near-Earth plasma to resolve time and space in three dimensions.

In addition, each spacecraft carries a different remote sensing payload to relate these in-situ measurements to the overall cusp and auroral oval morphology. The instruments flown on one spacecraft comprise an energetic particle detectors, neutral atom monitors, wave instruments and UV and X-ray imagers.

Orbit: The mission uses a Molniya orbit that enables the spacecraft to remain quasi-geostationary over the major European concentration of ground based equipment at Svalbard, and within the cusp and auroral regions, for many hours at a time. It is completely stable over the two year mission lifetime. The constellation does not require active maintenance.

Status: Proposed as an ESA F2/F3 Flexi-mission.

MagCon/DRACO Magnetospheric Constellation/Dynamics, Reconnection, And Configuration Observatory

Agency: NASA (United States)

Website: http://stp.gsfc.nasa.gov/missions/mc/mc.htm

Goal: Determine how the magnetotail stores, transports, and releases matter and energy.
Objectives:

- Determine the *equilibria* of the magnetotail.
- Understand the *responses* of the magnetotail to the solar wind.
- Reveal the *instabilities* of the magnetotail.
- Map the *linkages* between local and global processes.

Measurements: Magnetic field, plasma 2D temperature, plasma flux, plasma 3D velocity, electron PAD, particle energy (20-500 KeV),
particle flux, particle pitch angle.

Orbits: Constellation of 50-100 nano-satellites in elliptical orbits with dense sampling from 7 - 40 R_E with a resolution of 1-2 R_E.

Status: To be developed under Solar Terrestrial Probes program. Launch of 50-100 nano-satellites is deferred until after launch of MMS in 2012.

MCE Space Weather Monitoring Satellite.

Countries: Brazil, Russia.

Website: http://ilws.gsfc.nasa.gov/ILWS_Nice_Minutes_final.pdf

Goal: Measure electric and magnetic fields, cosmic rays, plasma, x-rays spending approximately one year in solar wind and then move to the magnetotail.

Measurements: Solar x-ray and UV detectors, solar cosmic ray detector, solar wind plasma detector, plasma wave/electric field detector, high energy particle detector.

Orbit: L1 orbit followed by transfer to quasi-polar orbit with 400,000 km apogee and low perigee.

Status: 2007-2008 launch with lifetime of 2-4 years. Same mission as Interball - PROGNOZ?

MESSENGER Mercury Surface, Space Environment, Geochemistry, and Ranging

Agency: NASA (United States)

Website: http://messenger.jhuapl.edu/

Goal: The MESSENGER mission, spacecraft, and science instruments are focused on answering outstanding questions that will allow us to understand Mercury as a planet including:

- What is the origin of Mercury's high density?
- What are the composition and structure of its crust?
- Has Mercury experienced volcanism?
- What are the nature and dynamics of its thin atmosphere and Earth-like magnetosphere?
- What is the nature of its mysterious polar caps?
- Is a liquid outer core responsible for generating its magnetic field?

Measurements:
Planetary Physics: Acquires data for studies of Mercury's crust and mantle, crustal composition, the core and magnetic dynamo, polar cap volatiles, and geologic evolution.

Space Environment:
Exosphere: The UV spectrometer will measure the composition and structure of Mercury's tenuous atmosphere and determine how it varies with local solar time, solar activity, and the planet's distance from the Sun. The energetic-particle spectrometer will measure the exchange of species between the exosphere and magnetosphere, and the plasma spectrometer will observe pick-up ions in the solar wind.

Magnetosphere: While the magnetometer maps the configuration and time-variability of Mercury's magnetic field, the combined plasma- and energetic-particle spectrometer will determine the types, abundances, and energetics and dynamical characteristics of ions trapped within.

Orbit: Two Venus flybys (June 2004, March 2006), two Mercury flybys (July 2007, April 2008), Mercury orbit begins April 6, 2009.

Status: Launch planned for March-May, 2004. MESSENGER is to enter Mercury orbit in April 2009 and carry out comprehensive measurements for one Earth year. Data collection concludes in April 2010.

MMS Magnetospheric Multiscale Mission

Agency: NASA (United States)

Website: http://stp.gsfc.nasa.gov/missions/mms/mms.htm

Goal: Investigate the fundamental plasma physics process of reconnection, particle acceleration, and turbulence on the micro- and mesoscales in the Earth's magnetosphere.
Reconnection: What are the kinetic processes responsible for collisionless magnetic reconnection? How is reconnection initiated? Where does reconnection occur at the magnetopause and in the magnetotail, and what influences where it occurs? How does reconnection vary with time, and what factors influence its temporal behavior? How are flux transfer events and plasmoids/magnetotail flux ropes formed, and how do they evolve?
Particle Acceleration: What is the role of inductive electric fields and wave-particle interactions in high-energy particle acceleration? How are particles accelerated in plasma injection events in the near-Earth tail? What are the mechanisms for accelerating charged particles at plasma boundaries?
Turbulence: What are the temporal and spatial properties of, and the physical processes responsible for, turbulence in the magnetosheath, magnetopause, and plasma sheet? What are the sources, propagation, and consequences of mesoscale boundary waves? What is the role of turbulence in plasma entry through the magnetopause?

Measurements: 3D composition resolved plasma (electron and ion) distribution functions from 1eV to 40 keV; 3D energetic ion distributions from 30 keV to several MeV and determining major species ion composition; electric field, plasma waves, and magnetic field.

Orbits: 4 identical spacecraft in a variably spaced tetrahedron (10 km to several R_E) with 4 orbit phases, orbit adjust, 2 year in-orbit (minimum) mission life. In Phases 1 and 2, the S/C cluster will be in a 10-degree inclination orbit. During Phase 1, the scientific emphasis will be on processes occurring at the low latitude dayside magnetopause and on substorm related processes in the near Earth magnetotail. Phase 2 will focus on the investigation of the dawnside flank of the equatorial magnetopause and the magnetotail at distances up to 30 Earth radii (RE), with special interest in substorm onset and evolution. Phases 3 will use lunar swingbys to take the S/C out to 120 RE in the deep tail and then to rotate the plane of the orbit to become perpendicular to the plane of the ecliptic. During this phase, MMS will investigate plasmoid evolution and the nature of merging at the distant neutral line. Phase 4 will be conducted from the 90 degree inclination orbit achieved through the rotation of the orbital plane during Phase 3 and will focus on the investigation of the entire dayside magnetopause, which it will skim from north to south, with additional interest in studies of the midtail.

Status: To be developed under Solar Terrestrial Probes program. Two teams selected to study scientific payload. Launch of 4 spacecraft planned for 2012.

MetOp EUMETSAT Polar Orbiting Satellites

Agency: EUMETSAT (Europe)

Websites: http://www.esa.int/export/esaME/index.html
http://www.eumetsat.de/ (See programmes under development)

Goal: Carry out the following missions:

- Operational Meteorology
- Climate monitoring
- Space Environmental Monitoring (SEM)
- Humanitarian service (Search and Rescue)

Measurements:
Earth Science: Uses a set of 'heritage' instruments from U.S. and a new generation of European instruments that offer improved remote sensing capabilities to both meteorologists and climatologists. The new instruments will augment the accuracy of:
temperature and humidity measurements, wind speed and wind direction measurements, especially over the ocean, and profiles of ozone in the atmosphere

Space Environment: SEM-2 Space Environment Monitor is a multichannel charged-particle spectrometer which measures the flux of charged particles at the satellite altitude (http://www2.ncdc.noaa.gov/docs/klm/html/c3/sec3-5.htm). SEM-2 is flown on the NOAA-K,-L,-M series of USA satellites and on the METOP-1, -2, -3 satellites of the EUMETSAT Polar System (EPS). The Total Energy Detector (TED) measures electron and proton energy fluxes in the 0.05 to 20 keV energy range. Independent measurements of the particle energy flux are made at zero and 30 degrees from the local vertical. The total energy measurement is divided into two ranges: 0.05 to 1 keV and 1 to 20 keV and each measurement is made independently for electrons and protons. The TED also measures the maximum differential energy flux density and the energy at which it occurs for each direction and particle type (electron and proton). The Medium Energy Proton Electron Detector (MEPED) provides both directional and omni-directional measurements. The directional sensors, called telescopes, make independent measurements of electrons and protons in several energy intervals protons 30-80 keV, 80-250 kev, 250-800 kev, 800-2500 kev, 2500-6900 kev, >6900 kev integral; electrons >30 kev integral, >100 kev integral, >300 integral. The omni-directional sensors measure proton energy in the following ranges: 16 MeV, 35 MeV, 70 MeV and 140 MeV.

Orbit: Polar at 800-850 km, Sun-synchronous, 99 degree inclination, period 101 min with local equatorial crossing times of 0930.

Status: In development. MetOp-1 launch planned for 2005. MetOp-2, MeTop-3 to be launched to maintain service over 14 years.

NOAA-POES NOAA Polar Orbiting Satellites

Agency: NOAA (United States)

Websites: http://www.oso.noaa.gov/poes/
http://www.oso.noaa.gov/poesstatus/
http://www.ipo.noaa.gov/About/sat_evolu.html

Goal: Serve as one of two types of satellites currently making up NOAA's operational weather satellite system monitoring the meteorological, oceanographic, and solar-terrestrial physics (geospace) environments. The geostationary operational environmental satellites (GOES) provide data for short-range warning and "now-casting" and the polar-orbiting satellites (POES) provide data for longer-term forecasting. Both types of satellites are necessary for providing a complete global weather monitoring system.

Measurements:
Geospace: SEM-2 Space Environment Monitor is a multichannel charged-particle spectrometer which measures the flux of charged particles at the satellite altitude (http://www2.ncdc.noaa.gov/docs/klm/html/c3/sec3-5.htm). SEM-2 is flown on the NOAA -K,-L,-M series of USA satellites and on the MetOp -1 -2, -3 satellites of the EUMETSAT Polar System (EPS). The Total Energy Detector (TED) measures electron and proton energy fluxes in the 0.05 to 20 keV energy range. Independent measurements of the particle energy flux are made at zero and 30 degrees from the local vertical. The total energy measurement is divided into two ranges: 0.05 to 1 keV and 1 to 20 keV and each measurement is made independently for electrons and protons. The TED also measures the maximum differential energy flux density and the energy at which it occurs for each direction and particle type (electron and proton). The

Medium Energy Proton Electron Detector (MEPED) provides both directional and omni-directional measurements. The directional sensors, called telescopes, make independent measurements of electrons and protons in several energy intervals protons 30-80 keV, 80-250 kev, 250-800 kev, 800-2500 kev, 2500-6900 kev, >6900 kev integral; electrons >30 kev integral, >100 kev integral, >300 integral. The omni-directional sensors measure proton energy in the following ranges: 16 MeV, 35 MeV, 70 MeV and 140 MeV.

Solar: Solar Backscatter UV Radiometer measures solar (and Earth) irradiance 160-400 nm (1 nm resolution). (see http://www2.ncdc.noaa.gov/docs/klm/html/c3/sec3-8.htm).

Orbits: Polar at 850 km, Sun-synchronous, 99 degree inclination, period 102 min with local equatorial crossing times of 730-1030 (AM) or 1330 (PM). METOP will cover AM orbits starting in late 2005. NPOESS will cover PM orbits starting in 2011.

Status: Operational.
NOAA-L (16) Launched 9/21/00 (PM orbit)
NOAA-M (17) Launched 6/24/02 (AM orbit)
(Backups NOAA-11,12,14,15)
NOAA-N Launch planned for 2004 (PM orbit)
NOAA-N' Launch planned for 2008 (PM orbit)

NPOESS U.S. National Polar-orbiting Operational Environmental Satellite System

Agency: NOAA, NASA, DOD (United States)

Websites: http://www.ipo.noaa.gov/about_NPOESS.html
http://www.ipo.noaa.gov/Technology/sensors.html

Goal: Serve as one of two types of satellites currently making up U.S. operational weather satellite system monitoring the meteorological, oceanographic, and solar-terrestrial physics (geospace) environments with the geostationary operational environmental satellites (GOES) for short-range warning and "now-casting" and the U.S. polar-orbiting satellites (POES, DMSP) for longer-term forecasting. Both types of satellites are necessary for providing a complete global weather monitoring system. The NPOESS spacecraft will replace and improve upon the capabilities of the POES and DMSP spacecraft.

Measurements:
Earth Science: Provides various atmospheric, oceanographic, and land parameters on a global basis.

Geospace: Space Environmental Sensor Suite, SESS measures neutral and charged particles, electron and magnetic fields, and optical signatures of aurora. Uses a complement of sensors and algorithms to measure the characteristics of: auroral boundary, auroral energy deposition, auroral imagery, electric field, electron density profile, geomagnetic field, in-situ plasma fluctuations, in-situ plasma temperatures, ionospheric scintillation, neutral density profile, medium energy charged particles, energetic ions, and supra-thermal to auroral energy particles. Global Positioning System Occultation Sensor (GPSOS) performs atmospheric sounding by radio occultation techniques providing global scale monitoring of ionospheric electron density profiles and scintillation properties, as well as tropospheric/stratospheric temperature, pressure and humidity profiles, with high accuracy and vertical resolution.

Solar: Total Solar Irradiance Sensor measures total solar irradiance plus a 0.2- 2 micron solar spectral irradiance. Solar Backscatter UV Radiometer measures solar (and Earth) irradiance 160-400 nm (1 nm resolution). (see http://www2.ncdc.noaa.gov/docs/klm/html/c3/sec3-8.htm).

Orbit: Polar, Sun-synchronous, Period 100 min. Local equatorial crossing times of 0530, 730-1030 (AM) or 1330 (PM).

Status: To be developed as successor to DMSP and NPOES programs.
NPOESS-C1 Launch planned for 2009 in AM orbit
NPOESS-C2 Launch planned for 2011 in PM orbit

NPOESS-C3 Launch planned for 2013 in 0530 local crossing time orbit
NPOESS-C4 Launch planned for 2015 in AM orbit
NPOESS-C5 Launch planned for 2017 in PM orbit
NPOESS-C6 Launch planned for 2018 in 0530 local crossing time orbit

Picard

Agency: CNES (France)

Websites: http://smsc.cnes.fr/PICARD/Fr/
http://ilws.gsfc.nasa.gov/France_Nice.pdf

Goal: Improve our knowledge of the solar forcing on the Earth's climate, the physics of the Sun, and its internal structure.

Measurements: Simultaneous measurement of the absolute total and spectral solar irradiance and the solar diameter and shape accuracy of a few milliarc sec. Probing the Sun's interior via helioseismology. Investigating terrestrial astmospheric ozone formation and destruction.

Orbit: Sun synchronous at an altitude between 730 and 750 km.

Status: To be developed, launch planned for late 2006 early 2007.

Polar

Agency: NASA (United States)

Website: http://www-spof.gsfc.nasa.gov/istp/polar/

Goals: Determine how the solar wind plasma energy enters into the magnetosphere through the polar cusp on the dayside of the magnetosphere. Determine the mechanisms that cause the ionospheric plasma outflow. Discern the importance and characteristics of various processes that accelerate the aurora-producing particles. Investigate the many ways in which energy and momentum are exchanged between the collisionless plasmas and with the electromagnetic fields accessible to the Polar spacecraft. From auroral images determine the rate of energy input into the atmosphere from auroral particles and their effects on the atmosphere.

Polar is an element of the the Global Geospace Science Program (GGS) designed to improve greatly the understanding of the flow of energy, mass and momentum in the solar-terrestrial environment with particular emphasis on "geospace". GGS has as its primary scientific objectives: a) Measure the mass, momentum and energy flow and their time variability throughout the solar wind-magnetosphere- ionosphere system that comprises the geospace environment; b) Improve the understanding of plasma processes that control the collective behavior of various components of geospace and trace their cause and effect relationships through the system; c) Assess the importance to the terrestrial environment of variations in energy input to the atmosphere caused by geospace plasma processes. The other GGS missions are Geotail and Wind. Complementary equatorial data are provided by the GOES spacecraft.

Measurements: Three of the twelve scientific instruments aboard the Polar satellite are used to image the aurora in various wavelengths when the satellite is near apogee, high over the northern polar region. The other nine instruments make measurements in-situ, at the location of the satellite, around the entire orbit. They measure the fluxes of charged particles, electrons and protons, as well as heavier ions, from thermal energies into MeV energies. They measure magnetic and electric fields, plus electromagnetic waves.

Orbit: Highly elliptical orbit, with apogee at 9 Re and perigee at 1.8 Re geocentric, with inclination of 86° and period about 18 hr. Initial apogee was over the northern polar region, but has been moving southward at about 16° per year.

Status: Operational. Launched February 24, 1996. Current NASA plan funds operations until September 2005.

Radiation Belt Storm Probes

Agency: NASA (United States)

Websites: http://lws.gsfc.nasa.gov/docs/Geospace/TownHall_2002AGU.pdf
http://lws.gsfc.nasa.gov/geospace.htm

Goal: Characterize and understand the acceleration, global distribution, and variability of the radiation belt electrons and ions that produce harsh environments for spacecraft and humans.
Scientific questions: Which physical processes produce radiation belt enhancements? What are the dominant mechanisms for relativistic electron loss? What role does the ring current play in radiation belt creation and loss?

Measurements: Main spacecraft: 20 keV - 20 MeV electrons; vector magnetic field and ULF waves; DC electric field; magnetic and electric VLF waves; ring current ions (20-600 keV), composition; plus if feasible: energetic protons (1-200 MeV), 0.01 - 20 keV ions and electrons. Smaller spacecraft: 20 keV - 1 MeV electrons, vector magnetic field and ULF waves; ring current ions (20-600 keV), composition. Plus, if feasible, ENA ring current imager on appropriate polar, high altitude spacecraft and on a platform in LEO orbit: precipitating energetic electrons (20 keV - 20 Mev) and proton monitor (1 - 200 MeV).

Orbits: Main spacecraft and trailing smaller spacecraft in near equatorial, elliptical orbits (approximately 500 km by 4.5 Re altitude).

Status: To be developed under Living With a Star program; launch planned for 2012 for 2 years with optional 3-year extension.

RAVENS Recurrent Auroral Visualization of Extended Northern Storms

Agency: CSA (Canada)

Website: http://ilws.gsfc.nasa.gov/Canada_Nice_03.pdf

Goal: Investigate storm-substorm relationships. Monitor effects of solar rotation on magnetospheric physics.

Measurements: Continuous auroal imaging, including start-to-finish imaging magnetic storms.

Orbit: Contraposing 2 spacecraft in elliptical polar orbits (apogee over north polar region) to provide unbroken imaging.

Status: Under study. Launch to provide coverage in 2007-2010+ time period.

RESONANCE

Agencies: IKI, IPF (Russia)

Websites: http://ilws.gsfc.nasa.gov/russia_cospar.pdf
http://www.iki.rssi.ru/resonance/ang1.html
Http://bird.iki.rssi.ru/Resonance
http://ilws.gsfc.nasa.gov/Russia_Nice.pdf

Goal: Investigate wave-particle interactions and plasma dynamics in the inner magnetosphere. Magnetospheric science and space weather-related investigations of:

- Ring current and outer radiation belt.
- Plasmasphere.
- Magnetospheric cyclotron maser.
- Mid-altitude auroal zone and polar cap.

Measurements: 3D magnetic field, DC and ULF electric field, ELF/VLF electronmagetic field, HF electromagnetic field, plasma density and temperature (thermal and hot plasmas).

Orbits: Two spacecraft in agnetosynhronous orbits: apogees about 30,000 km, perigees about 1800 km, and inclinations + and - 63.4 degrees.

Status: Under investigation.

RHESSI Ramaty High Energy Solar Spectroscopic Imager

Agency: NASA (United States)

Website: http://hesperia.gsfc.nasa.gov/hessi/

Goal: Explore the basic physics of particle acceleration and energy release in solar flares:

- Determine the frequency, location, and evolution of impulsive energy release in the corona. Study the acceleration of electrons, protons, and heavier ions in flares.
- Study the heating of plasma to tens of millions of degrees and determine its relationship to particle acceleration.
- Study the propagation and evolution of energetic particles in flares.
- Determine the relative abundances of accelerated and ambient ions in flares.

Scientific questions: What role do high energy particles play in the energy release process? Do the high energy particles carry a significant fraction of the released energy? What mechanisms accelerate both electrons and ions to high energies so rapidly and efficiently? What is the environment in which this energy release occurs? What mechanisms transport the flare energy, the energetic particle component in particular, away from the energy release site? What are the characteristic radiation signatures of flares that have potentially hazardous effects, and how do these flares occur and evolve?

Measurements:
Hard X-ray images (angular resolution: 2 - 7 arcsec, temporal resolution: 10's ms, energy range: 3 keV to 400 KeV). High-resolution X-ray spectra (energy resolution 0.5 - 2 keV; range 3 - 400 keV). High-resolution gamma-ray spectra (energy resolution 2 - 5 keV, range 400 keV - 20 MeV). Gamma-ray images (angular resolution 7 - 30 arcsec, energy range 400 keV - 20 MeV).

Orbit: Circular with altitude of 600 km and inclination of 38 degrees

Status: Operational. Launched February 15, 2002. Current NASA plan funds operations until 2007.

ROY/SCHWARM

Agencies: RASA (Russia), DRL (Germany)

Websites: http://ilws.gsfc.nasa.gov/russia_cospar.pdf
http://ilws.gsfc.nasa.gov/Russia_Nice.pdf
http://bird.iki.rssi.ru/ROY/ (May not be accessible)

Goals: *Fundamental plasma phenomena studies:* Explosive transformation of magnetic energy into plasma thermal and kinetic energies. *In situ multi-point measurements:* Magnetospheric plasma boundaries dynamics; mass and energy transport through the magnetopause; substorm generation; strong plasma turbulence; magnetic field annihilation. *Remote scanning by radio-tomography at space scales (10 - 300 km):* Probing multi-scale structures in critical regions of the magnetosphere.

Orbits: Group of spacecraft in orbits with apogee of 75,000-100,000 km and perigee of 10,000-12,000 km, inclination 62.8 degrees.

Status: Under study.

SAMPEX Solar Anomalous and Magnetospheric Particle Explorer

Agency: NASA (United States)

Website: http://surya.umd.edu/www/sampex.html

Goal: Investigate:

- Cosmic Rays: Ionization states, energy spectra, isotopic composition,of galactic and anomalous cosmic rays.
- Solar Energetic Particles (SEP): Isotopic composition, impulsive event spectra, ionization states of large SEP events; SEP with anomalously low ionization states.
- Magnetospheric Physics: Acceleration mechanisms, global surveys, precipitation bursts of relativistic electrons and protons. Space weather.
- Magnetospheric-Atmospheric Link: Energy input from precipitating electrons influencing middle atmosphere Noy which affect global ozone levels.

Measurements: Heavy ions from He to Fe in the energy range from 8 to 220 MeV/nucleon for oxygen, covering the medium- energy solar energetic ions, galactic cosmic rays, and the range of maximum intensity of the anomalous cosmic ray component. Measure ~0.5 - 5 MeV/nucleon solar and magnetospheric ions over the range from He - Ni. Measure the isotopic composition of elements from Li (Z=3) to Ni (Z=283 in the range from approximately 10 MeV/nucleon to several hundred MeV/nucleon.

Orbit: Altitude 520 by 670 km and inclination 82 degrees inclination.

Status: Operational, launched July 3, 1992. Current NASA plan funds operations until mid 2004.

SCOPE

Agency: ISAS (Japan)

Website: http://ilws.gsfc.nasa.gov/ILWS_Nice_Minutes_final.pdf

Goal: Fly mother and four tiny spacecraft in geomagnetic tail.

Status: Under study. Launch in 201?

SDO Solar Dynamics Observatory

Agency: NASA (United States)

Website: http://sdo.gsfc.nasa.gov/

Goals:

- Understand the Solar Cycle.
- Identify the role of the magnetic field in delivering energy to the solar atmosphere and its many layers.
- Study how the outer regions of the Sun's atmosphere evolve over time - ranging from seconds to centuries - and space.
- Monitor the solar output of radiation (UV, EUV, etc.)

Measurements:

The Helioseismic and Magnetic Imager will extend the capabilities of the SOHO/MDI instrument with continuous full-disk coverage at considerably higher spatial and temporal resolution line-of-sight magnetograms and also provide vector magnetograms. Stabilized 1 arc-second resolution full-disk Doppler velocity and line-of-sight magnetic flux images at least every 50 seconds and stabilized 1 arc-second resolution full-disk vector-magnetic images of the longitudinal solar magnetic field at least every 90 seconds.

The Atmospheric Imaging Array images the solar atmosphere simultaneously in multiple wavelengths (UV and EUV bandpasses) and corona to 15 solar radii to link changes to surface and interior changes.

The Extreme Ultraviolet Variablity Experiment will measure the solar EUV irradiance with unprecedented spectral resolution, temporal cadence, and precision. Measures the 4-120 nm spectral irradiance (0.1 nm spectral resolution and with 10-second cadence), measures 0.1-5 nm, 17-34 nm, 53-60 nm, and 119-125 nm bands (1-second cadence).

Orbit: Inclined geosynchronous orbit (35,800 km).

Status: To be developed under Living With a Star program; launch planned for April 2008 with 5 year design life.

Sentinels

Agency: NASA (United States)

Website: http://lws.gsfc.nasa.gov/sentinels.htm

Goals:
- Understand the transition and evolution of eruptions and flares from the Sun to the Earth's magnetosphere.
- Discover, model and understand the connection between solar phenomena and Geospace disturbances.

Scientific objectives:
- Determine the structure and long-term climatic variations of the ambient solar wind in the inner heliosphere.
- Determine how geo-effective solar wind structures propagate and evolve in the inner heliosphere.
- Determine what solar dynamic processes are responsible for the release of geo-effective events.
- Determine how and where energetic particles are released and accelerated.

Measurements: Instruments on several spacecraft observing the Sun and heliosphere via remote sensing techniques and measuring the solar wind in situ. Complements missions studying geospace, Solar Orbiter, and possibly Solar Probe.

Orbits: Several spacecraft in heliocentric orbits; concepts under study.

Status: To be developed under Living With a Star program, spacecraft to be launched starting about 2012.

Sich-1M Ukranian Remote Sensing Satellite

Country: Ukraine.

Websites: http://ilws.gsfc.nasa.gov/Ukraine_Nice.pdf http://ilws.gsfc.nasa.gov/ILWS_Nice_Minutes_final.pdf

Goal: Ionospheric Studies. Measure electric and magnetic fields that will characterize field-aligned currents.

Measurements: Ionospheric electric and magnetic fields.

Orbit: Polar Sun-synchronous orbit, altitude 670 km.

Status: In development. To be launched by end of year 2003.

SMART-1 **S**mall **M**issions for **A**dvanced **R**esearch and **T**echnology

Agency: ESA (Europe)

Website: http://sci.esa.int/home/smart-1/index.cfm

Goal: Test solar electric propulsion and other deep-space technologies, while performing scientific observations of the Moon. Scientific objectives include investigating the origin of the Moon, searching for ice in the craters at the Moon's south pole, and acquiring some solar-terrestrial data.

Measurements: Seven instruments will address technology and lunar science objectives. Two instruments will acquire solar-terrestrial data. The XSM instrument will monitor solar X-rays for studying solar X-ray variability and for calibrating SMART-1 measurements of lunar composition (which are affected by variations in solar X-ray emissions).

The SPEDE instrument will monitor the effect of the electric propulsion system on the spacecraft and investigate the electrical environment of the Earth-Moon space. During SMART-1's cruise phase, the SPEDE experiment will map the plasma density distribution around the Earth and when SMART-1 is in lunar orbit, it will study the lunar plasma environment and notably how the solar wind is coupled to the Moon.

Orbit: 16-month transfer orbit from Earth to the Moon. The final operational science orbit is a polar elliptical orbit, ranging from 300 km to 10,000 km above the Moon.

Status: Launched September 27, 2003 on a 2 to 2.5 year mission.

SMEI Solar Mass Ejection Imager on Coriolis spacecraft

Agencies: University of California San Diego (USA), University of Birmingham (UK), Rutherford Appleton Laboratory (UK), the Air Force Research Laboratory (USA), and Boston College (USA).

Websites: http://cassfos02.ucsd.edu/solar/smei_new/smei.html
http://www.spectrumastro.com/PDFs/Coriolis-Web.pdf

Goal:
Solar-Heliospheric: Provide input for space weather forecasting by detecting Coronal Mass Ejections (CME's), imaging their structures, and tracking them from the Sun to near-Earth space. SMEI should provide advanced warning of one to three days of impending geomagnetic storms.
Earth Science: Passively measure ocean surface wind vector.

Measurements: Measure the heliospheric Thomson electron scattering white light brightness over the whole sky (SMEI experiment). Measure ocean surface wind vector (Windsat polarimetric microwave experiment).

Orbit: Sun-synchronous at altitude of 850 km.

Status: SMEI instrument was launched on the Coriolis Mission spacecraft on January 6, 2003, on a three year mission and began returning images on February 1.

SOHO Solar and Heliospheric Observatory

Agencies: ESA (Europe), NASA (United States)

Websites: http://sohowww.estec.esa.nl/
http://sci.esa.int/home/soho/index.cfm
Http://sohowww.nascom.nasa.gov/
http://ilws.gsfc.nasa.gov/ESA_Nice.pdf

Goals: Study the internal structure of the Sun, its extensive outer atmosphere and the origin of the solar wind, the stream of highly ionized gas that blows continuously outward through the Solar System. Study the heating of the solar corona, the acceleration of the solar wind, and the physical conditions in the solar interior.

Measurements:
Solar Interior: Two instruments acquire long and uninterrupted series of oscillations velocity and irradiance measurements of the full solar disk and obtain information about the solar nucleus. A third third measures oscillations on the surface of the Sun with high angular resolution to obtain information about the Sun's convection zone - the outer layer of the solar interior.

Solar Atmosphere: Three instruments (EUV/XUV telescopes and spectrometers) observe the inner corona. White light and UV coronagraphs observe both inner and outer corona. These instruments measure coronal temperatures, densities, composition, and velocities and follow the evolution of coronal structures.

Solar Wind: Three instruments analyze *in situ* the charge state and isotopic composition of ions in the solar wind, and the charge and isotopic composition of energetic particles generated by the Sun. A fourth instrument make maps of the hydrogen density in the heliosphere from ten solar diameters allowing the large-scale structure of the solar wind streams to be measured.

Orbit: Halo orbit around the L1 Lagrangian point 1.5 million kilometers sunward of the Earth.

Status: Operational; launched December 2, 1995. Current NASA plan has funding for operations until launch of SDO plus 6-12 months; current ESA plan has funding for operations until early 2006.

SOL-ACES

Country: Germany

Website: http://ilws.gsfc.nasa.gov/ILWS_Nice_Minutes_final.pdf

Measurements: Measures EUV/UV solar fluxes.

Status: To be flown on International Space Station. Planned flight in 2005.

SOLAR-B

Agencies: ISAS (Japan), NASA (United States), PPARC (Great Britain)

Websites: http://www.isas.ac.jp/e/enterp/missions/index.html
http://stp.gsfc.nasa.gov/missions/solar-b/solar-b.htm
http://science.msfc.nasa.gov/ssl/pad/solar/solar-b.stm
http://ilws.gsfc.nasa.gov/Japan_Nice.pdf

Goal: Investigate:
- Creation and Destruction of the Sun's Magnetic Field
- Modulation of the Sun's Luminosity
- Generation of UV and X-ray Radiation
- Eruption and Expansion of the Sun's Atmosphere

Measurements: Solar Optical Telescope with angular resolution 0.25" and wavelength range 480-650nm feeding a Magnetograph providing vector magnetic field and Doppler velocity measurements, photospheric intensities (field of view of 164x164 arcsec squared, temporal resolution of 5 min) and a spectrograph providing detailed Stokes line profiles of intensity and polarization.

X-Ray Telescope with wavelength range of 2.0 to 60.0 Å, angular resolution of 1.0 to 2.5 arcsec, field of view giving full or partial disk, providing coronal images at different temperatures.

EUV Imaging Spectrograph with pixel size of 1.5 arcsec x 0.002nm, field of view of 400 arcsec, wavelength range 25-29nm, and temperature range 1 x 10e5 - 2 x 10e7 K, providing Doppler line widths and shifts and monochromatic images.

Orbit: Polar at 600 km, Sun synchronous, inclination 97.9 degrees.

Status: In development, launch planned in September, 2006.

Solar Orbiter

Agency: ESA (Europe)

Websites: http://solarsystem.estec.esa.nl/solar_physics/projects/solar_orbiter.htm
http://sci.esa.int/home/solarorbiter/index.cfm
http://ilws.gsfc.nasa.gov/esa_cospar.pdf
http://ilws.gsfc.nasa.gov/ESA_Nice.pdf
http://ilws.gsfc.nasa.gov/esa_kickoff.pdf

Goals: For the first time**:**
- Explore the uncharted innermost regions of our solar system,
- Study the Sun from close-up (45 solar radii, or 0.21 AU),
- Fly by the Sun, tuned to its rotation and examine the solar surface and the space above from a co-rotating vantage point,
- Provide images of the Sun's polar regions from heliographic latitudes as high as 38 degrees.

Scientific goals:
- To determine *in-situ* the properties and dynamics of plasma, fields and particles in the near-Sun heliosphere,
- To investigate the fine-scale structure and dynamics of the Sun’s magnetised atmosphere, using close-up, high-resolution remote sensing,
- To identify the links between activity on the Sun's surface and the resulting evolution of the corona and inner heliosphere, using solar co-rotation passes,
- To observe and fully characterise the Sun's polar regions and equatorial corona from high latitudes.

Measurements: Co-rotation remote sensing observations. In-situ diagnostics of innermost heliosphere (to within 0.21 AU of Sun), close-up high resolution solar imaging and spectroscopy. Heliocentric orbit up to 38 degrees out of ecliptic will yield topside view of solar polar regions and coronal mass ejections and observations of the backside of Sun. Instruments include solar wind plasma analyser, radio & plasma waves analyser, coronal radio sounding, magnetometer, energetic particle detector, dust detector, neutral particle detector, neutron detector, visible light imager and magnetograph, EUV spectrometer, EUV imager, UV and visible light coronagraph, and radiometer.

Orbit: Heliospheric passing within 45 solar radii (or 0.21 AU) of Sun; inclination as high as 38 degrees from ecliptic.

Spacecraft: To be developed, launch planned for 2011.

Solar Probe

Agency: NASA (United States)

Website: http://ilws.gsfc.nasa.gov/NASA_Nice.pdf

Goal: Determine where and what physical processes heat the corona and accelerate the solar wind to its supersonic velocity.

Measurements: *In situ:* solar wind electron and ion composition, magnetometer, energetic particle composition, plasma wave sensor, fast soalr wind ion detector, dust monitor to characterize the solar wind within a high-speed stream; characterize the plasma in a closed coronal structure and probe the sub-sonic solar wind; characterize the changes in the solar wind during the cruise from Jupiter to the Sun during extreme conditions of solor variability; characterize plasma waves, turbulence, and/or shocks that cause coronal heating. *Remote sensing:* EUV and white-light imagers for field topology and context for in situ observations; imaging the longitudal structure of the white light corona from polor viewpoints.
Orbit: Heliocentric, polar orbit with perhelion at about 4 Rsun, aphelion at Jupiter's orbit at 5 AU.

Status: Under study. Launch 2010 - 2015.

SORCE Solar Radiation and Climate Experiment

Agency: NASA (United States)

Websites: http://lasp.colorado.edu/sorce/
http://eospso.gsfc.nasa.gov/eos_homepage/mission_profiles/index.php

Goal: Provide state-of-the-art measurements of incoming x-ray, ultraviolet, visible, near-infared, and total solar radiation for studies of long-term climate change, natural variability of climate, climate prediction, and variation of atmospheric ozone and UV-B radiation.

Measurements: The Total Irradiance Monitor (TIM) will observe the Sun for five years and measure the total solar irradiance. The Spectral Irradiance Monitor will provide the first long-duration solar spectral irradiance measurements in the visible and near infrared (Vis/NIR). The wavelength coverage is primarily from 300 to 2000 nm, with an additional channel to cover the 200-300 nm ultraviolet spectral region to overlap with SOLSTICE. The SOlar Stellar Irradiance Comparison Experiment (SOLSTICE) will make daily solar ultraviolet (115-320 nm) irradiance measurements and compare them to the irradiance from an ensemble of 18 stable early-type stars. This approach provides an accurate monitor of instrument in-flight performance and provides a basis for solar-stellar irradiance comparison. The SORCE XPS will complement and continue solar XUV irradiance measurements made with instruments on SOHO, SNOE, and TIMED with improvements in accuracy, spectral image, and temporal change. The XPS measures the solar soft x-ray (XUV) irradiance from 1 to 34 nm and the bright hydrogen emission at 121.6 (H I Lyman-alpha).

Orbit: 645 km, 40 degree inclination.

Status: Operational. Launched January, 25, 2003

SST Solar Space Telescope

Agency: CNSA (China)

Websites: http://ilws.gsfc.nasa.gov/Space_Solar_Telescope.pdf
http://www.astronautix.com/craft/sst.htm
http://www.spacetoday.org/China/ChinaSatellites.html

Goals:

- Explore the 3D structure of vector magnetic fields and velocity fields with about 0.1" spatial resolutions by means of 2D real time polarizing spectrograph and Stokes parameter profiles.
- Explore the fine structures of the solar atmosphere, especially the heating of the chromosphere and corona.
- Study the energy build up, storage, triggering, and release of solar flares; study the fine scale evolution of solar active regions, sunspots, and prominences.
- Study various solar transient phenomena associated with the solar terrestrial space environment, and provide various parameters for forecasting solar terrestrial activity.

Measurements: Optical diffraction-limited 1m telescope, 8 channel 2-D real time polarizing spectrograph, EUV imaging telescope (129, 171, 195, and 304 Angstroms), wide band spectrometer for soft X-rays (2-30 Kev) with 64 channels, hard X-rays (15-450 Kev) with 64 channels, and Gamma-rays (0.3-14 Mev) with 128 channels, H-alpha and white light finder telescope (1" resolution), and a solar and interplanetary radio spectrometer (100K-60MHz).

Orbit: Sun-synchronous 800 km orbit

Status: Planned launch date 2005 with 3 year lifetime.

ST5 Space Technology 5

Agency: NASA (United States)

Website: http://nmp.jpl.nasa.gov/st5/st5-index.html

Goal: ST5's objective is to demonstrate and flight qualify innovative technologies and concepts for application to future space missions employing low cost nanosats such as Magnetospheric Constellation/DRACO.

Measurements: ST5 will launch multiple miniature spacecraft, called nanosats or small-sats, to test innovative concepts and technologies in the Earth's magnetosphere. During flight validation of its technologies, ST5 may measure some aspects of the effects of solar activity on the Earth's magnetosphere.

Orbit: ST5 will be launched as a secondary payload with specific orbit depending on launch opportunity utilized.

Status: In development, launch planned for December 2004.

STEREO Solar Terrestrial Relations Observatory

Agency: NASA (United States)

Websites: http://stp.gsfc.nasa.gov/missions/stereo/stereo.htm
http://stereo.jhuapl.edu/

Goal: Acquire data to develop an understanding of the fundamental nature and origin of coronal mass ejections – the most energetic eruptions on the sun and primary cause of major geomagnetic storms. The mission will use stereoscopic vision to construct a global picture of the sun and its influences. Specific objectives:

- Solar origins and development of coronal mass ejections.
- Propagation of ejections and disturbances from Sun to Earth.

- Mechanisms of solar energetic particle acceleration in low corona and interplanetary medium.
- 3-D structure and dynamics of corona and heliosphere.

Measurements: A suite of remote-sensing instruments consisting of an extreme ultraviolet imager, two white-light coronagraphs, and a heliospheric imager. These instruments will study the 3-D evolution of coronal mass ejections from their origin at the sun's surface through the corona and interplanetary medium to their eventual impact at Earth. A suite of seven in situ instruments including a solar wind electron analyzer, a magnetometer, and an array of particle detectors measuring the energetic ions and electrons accelerated in coronal mass ejection (CME) shocks and in solar flares provides measurements of the solar wind electrons, interplanetary magnetic fields, and solar energetic particles. An instrument to study coronal-solar wind and solar wind-heliospheric processes via measurements in situ of plasma characteristics of protons, alpha particles and heavy ions. It will supply key diagnostic measurements of mass and charge state composition of heavy ions and will characterize the coronal mass ejection plasma from ambient solar wind plasma. An interplanetary radio burst tracker to trace the generation and evolution of traveling radio disturbances from the sun to Earth's orbit.

Orbits: Heliocentric 1 AU orbits, one spacecraft leading the Earth and one trailing to provide stereo viewing capability.

Status: In development, launch planned for November 2005 with both spacecraft launched on one launch vehicle.

STORMS

Country: Finland

Websites: http://sci.esa.int/content/doc/43/24387_.htm
http://ilws.gsfc.nasa.gov/esa_cospar.pdf

Goal: Flight of a three-spacecraft constellation for Earth magnetic storms and inner magnetospheric studies. The most important scientific problems to be addressed are:

- Growth and decay of the ring current and the role of ionospheric oxygen;
- Effects of different current systems on ground determination of storms;
- Storm-substorm relationship;
- Particle injection and acceleration mechanism;
- Dynamics of the plasmasphere;
- Plasma sheet and substorms;
- Forecasting of storms (space weather).

Measurements: Instrumentation for measurement of charged particles and electric and magnetic fields; Energetic Neutral Atom analyser for magnetospheric imaging and follow in real-time its spatio-temporal variations.

Orbit: Equatorial orbits with with apogee altitudes of 45,000 km and perigee altitudes of 700 m, and with line-of-apsides separated by 120deg +/-20deg.

Status: Under study with the earliest technically feasible launch date being mid-2007.

SWARM

Countries: Denmark, Germany, United Kingdom

Websites: http://www.dsri.dk/smaasatellit/swarm.html
http://ilws.gsfc.nasa.gov/esa_cospar.pdf
http://ilws.gsfc.nasa.gov/esa_kickoff.pdf
http://www.esa.int/export/esaCP/Pr_38_2002_p_EN.html
http://ilws.gsfc.nasa.gov/ILWS_Nice_Minutes_final.pdf

Goal: Survey the geomagnetic field and its changes over time, with an accuracy never yet reached.

Scientific objectives:
- Studies of high-latitude ionospheric and field-aligned current systems.
- Estimation of the time-space structure of the polar and equatorial electrojets; analysis of their variability, for example with the solar wind.
- Investigation of the day-to-day variability of ionospheric currents at middle and low latitudes.
- Modeling of the core field and its secular variation.
- Determination of the crustal field.
- Tomography of the electron density in the ionosphere.
- Atmospheric profiling of temperature, humidity and other meteorological parameters.

Measurements: High-precision magnetometers, GPS receivers, ion drift meter (electric fields), accelerometer (atmosphere density drag).

Orbits: Constellation of four satellites in two different polar orbits at altitudes ranging from 400 and 550 kilometers.

Status: In phase A study by ESA, if selected for development, launch planned for 2009 or later. Phase A study on merging ACE+ and SWARM to be completed by end of 2003.

SWISE Solar Wind and Storm Exploration

Agency: CNSA (China)

Website: http://ilws.gsfc.nasa.gov/China_Nice.pdf

Goal: To understand the response process of geospace weather to solar activity and interplanetary disturbances.
Scientific Objectives:
To explore near-magnetosphere solar wind, magnetopause boundary layer, and near-Earth magnetospheric active regions, and temporal-spatial variations of ionospheric and themospheric disturbances; to study the driving and triggering mechanisms of geospace storms, as well as their response to solar activity and interplanetary disturbances.
Research Objectives:
- The response process of near-Earth solar wind to solar activity.
- The structure and dynamics of the bow shock, magnetosheath, and magnetopause under different interplanetary conditions.
- The driving and triggering mechanisms of magnetospheric substorms and geomagnetic storms.
- The relation between magnetospheric substorms and geomagnetic storms, and their influences on the magnetospheric particle environment.
- The relation between ionospheric storms and thermospheric storms, as well as their response process to solar activity and interplanetary conditions.

Measurements: SWISE-1 to measure magnetic field; ionospheric low- and high-energy particles, waves, energetic neutrals, thermospheric winds and temperatures; solar UV radiation; auroral images.
SWISE-2 wil measure the magnetic field, low- and high-energy particles, energetic neutrals; image the aurora, and actively control the spacecraft potential.
SWISE-3 will measure the magnetic field, low- and high energy particles, electromagnetic waves, and actively control the spacecraft potential.

Orbits: To be launched on single rocket in 65 degree inclination orbits. SWISE-1 in a 300 by 700 km orbit; SWISE-2 in a 700 km by 7.5 RE orbit; SWISE-3 in a 2 by 22 RE orbit. All three spacecraft are spin stabilized.

Status: Under study, to be launched in 2010-2012 if approved.

TechnoSat

Agency: Swedish National Space Board

Website: http://ilws.gsfc.nasa.gov/ILWS_Nice_Minutes_final.pdf

Goal: Flight testing space technologies.

Measurements: Proposed tests of wire boom systems; plasma instrument package; other space technologies.

Status: Phase A funded, starting in spring 2003. Planned launch in 2-3 years.

THEMIS Time History of Events and Macroscale Interactions During Substorms

Agency: NASA (United States)

Websites: http://sprg.ssl.berkeley.edu/themis/
http://fpd.gsfc.nasa.gov/410/index.html

Goals: Answer fundamental outstanding questions regarding the magnetospheric substorm instability, a dominant mechanism of transport and explosive release of solar wind energy within Geospace. Elucidate which magnetotail process is responsible for substorm onset at the region where substorm auroras map (~10Re): (i) a local disruption of the plasma sheet current or (ii) that current's interaction with the rapid influx of plasma emanating from lobe flux annihilation at ~25Re. Correlative observations from long-baseline (2-25 Re) probe conjunctions, to delineate the causal relationship and macroscale interaction between the substorm components.

Measurements: Five identical spacecraft (probes) measure particles and fields on orbits which optimize tail-aligned conjunctions over North America. Ground observatories time auroral breakup onset. Three inner probes at ~10Re monitor current disruption onset, while two outer probes, at 20 and 30Re respectively, remotely monitor plasma acceleration due to lobe flux dissipation. Measure 3D magnetic and electric field vectors and waveforms. Electron and ion particle measurements in energy range 5eV-30 keV and 20 keV - 1 MeV.

Orbits: Three inner probes with apogees at 10Re (perigees of 2.56 and 2.9 Re) and 12Re (perigee 1.25Re), two outer probes with apogees at 20 and 30Re (perigees about 3.25 Re).
Orbital periods ae about 24 hours for the three inner probes and 48 and 93 hours for the two outer probes.

Spacecraft: Under study, if selected for development, launch of 5 identical spacecraft planned for August 2006.

TIMED Thermosphere-Ionosphere-Mesosphere Energetics and Dynamics mission

Agency: NASA (United States)

Websites: http://www.timed.jhuapl.edu/
http://stp.gsfc.nasa.gov/

Goal: To understand the mesosphere-lower thermosphere-ionosphere (MLTI) region's basic pressure, temperature and wind that result from the transfer of energy into and out of this region.

Measurements: A spatial scanning, far-ultraviolet spectrograph measures globally the composition and temperature profiles of the MLTI region, as well as its auroral energy inputs. An EUV spectrometer measures the solar soft x-rays, extreme ultraviolet and far ultraviolet radiation deposited into the MLTI region. A Doppler interferometer measures globally the wind and temperature profiles of the MLTI region. A infrared radiometer measures heat emitted by the atmosphere over a broad altitude and spectral range, as well as global temperature profiles and sources of atmospheric cooling.

Orbit: 625 km altitude circular orbit with inclination of 74.1 degrees.

Status: Operational. Launched December 7, 2001. Current NASA plan funds operations until March 2007.

TRACE Transition Region and Coronal Explorer

Agency: NASA (United States)

Website: http://vestige.lmsal.com/TRACE/

Goal: Explore the magnetic field in the solar atmosphere by studying:
- The 3-dimensional field structure.
- Its temporal evolution in response to photospheric flows.
- The time-dependent coronal fine structure.
- The coronal and transition region thermal topology.

Investigate:
- The mechanisms of the heating of the outer solar atmosphere.
- The triggers and onset of solar flares and mass ejections.

Measurements: TRACE acquires images over an 8.5 x 8.5 arc min field of view with 1 arc sec resolution (0.5 arc sec pixels) in UV and EUV spectral lines and continua (FeXV, FeXII, FeIX, CIV, HLyAlpha spectral lines), UV continua at 1600 Angstrom), and white light continuum spanning a temperture range from approximately 5000 to 4 million degrees K.

Orbit: Perigee 600 km, apogee 650 km, Inclination 97.8 degrees, Sun synchronous.

Status: Operational. Launched April 2, 1998. Current NASA plan funds operations until 2007.

TWINS Two **W**ide-angle **I**maging **N**eutral-atom **S**pectrometers

Agency: NASA (United States)

Websites: http://nis-www.lanl.gov/nis-projects/twins/
Http://fpd.gsfc.nasa.gov/410/index.html

Goal: Enable the 3-dimensional visualization and the resolution of large scale structures and dynamics within the magnetosphere via stereo imaging energetic neutral atom imaging from two spacecraft.

Scientific Objectives: Establish global connectivities and causal relationships between processes in different regions of the magnetosphere.
- Ion Dynamics: view global dynamics, composition, and energization of ions throughout the magnetosphere.
- Plasma Origins and Destinies: trace sources, transport, and sinks of plasma populations.
- Magnetospheric Evolution: observe the evolution of the global magnetospheric structure.
- Magnetospheric Structure: visualize and map the global configuration of the magnetosphere in three dimensions.

Measurements: Neutral atom imaging covering the ~1-100 keV energy range with 4^ox4^o angular resolution and 1-minute time resolution, and Lyman-alpha imaging to monitor the geocorona.

Orbits: TWINS will fly on two high-inclination, high altitude spacecraft provided by a non-NASA US organization in Molniya orbits with 63.4^o inclination and 7.2 R_E apogee.

Status: Launches planned for 2ndQ 2004 and 2ndQ2005.

UARS Upper Atmosphere Research Satellite

Agency: NASA (United States)

Website: http://umpgal.gsfc.nasa.gov/uars-science.html

Goal: Help define the role of the upper atmosphere in climate and climate variability. The UARS mission objectives are to provide an increased understanding of:

- Energy input into the upper atmosphere;
- Global photochemistry of the upper atmosphere;
- Dynamics of the upper atmosphere;
- The coupling among these processes; and
- The coupling between the upper and lower atmosphere.

Measurements:

Earth Science: Measure ozone and chemical compounds found in the ozone layer which affect ozone chemistry and processes. Measure winds and temperatures in the stratosphere as well as the energy input from the Sun. Also measures temperatures, emission rate, and winds from the visible region airglow that exists at altitudes of 80 - 300 km, at the top of the atmospheric region studied with the UARS spacecraft.

Solar: Measure solar flux over its 115-410 nm wavelength range daily at 1 and 5 nm resolutions and weekly at 0.15 nm resolution.

Orbit: Altitude 600 km, inclination 57 degrees.

Status: Launched on September 15, 1991. Eight of 10 instruments still functioning.

Ulysses

Agencies: ESA (Europe), NASA (United States)

Websites: http://sci.esa.int/home/ulysses/index.cfm
http://ulysses.jpl.nasa.gov/

Goal: The primary mission of the Ulysses spacecraft is to characterize the heliosphere as a function of solar latitude.

Measurements: In situ particles and fields measurements (magnetic field; solar wind temperature, density, composition; plasma waves; energetic particles; solar x-rays and cosmic gamma-ray bursts; dust; gravitational waves.

Orbit: Heliocentric ranging between 1.3 and 5.4 AU from Sun, inclination 80 degrees.

Status: Operational. Launched October 6, 1990. Current NASA plan funds operations until March 2008.

Venus Climate Orbiter

Agency: ISAS (Japan)

Status: Under study. Planned launch date 2008.

Venus Express

Agency: ESA (Europe)

Website: http://sci.esa.int/home/venusexpress/index.cfm
http://ilws.gsfc.nasa.gov/esa_cospar.pdf

Goal: Address the problems of atmospheric escape and plasma environment.

Measurements: In situ measurements of ENA, ions, electrons, and magnetic fields. Active radar sounding of the verticle structure of the topside ionosphere. High resolution spectroscopic observations of CO_2 and H_2O. Remote sounding of solar wind turbulence.

Orbit: Polar orbit about Venus in elliptical orbit with minimum altitude of 250 km and its maximum altitude 66 000 km.

Status: In development with launch planned for November 2005. The mapping mission is due to last for 2 Venusian days, about 500 Earth days.

Voyager I & II

Agency: NASA (United States)

Website: http://voyager.jpl.nasa.gov/

Goals: The objective of the Voyager Interstellar Mission is to extend the exploration of the solar system beyond the neighborhood of the outer planets to the outer limits of the Sun's sphere of influence, and possibly beyond. To characterize the outer solar system environment and search for the heliopause boundary, the outer limits of the Sun's magnetic field and outward flow of the solar wind. Penetration of the heliopause boundary between the solar wind and the interstellar medium will allow measurements to be made of the interstellar fields, particles and waves unaffected by the solar wind.

Measurements: The strength and orientation of the Sun's magnetic field; the composition, direction and energy spectra of the solar wind particles and interstellar cosmic rays; the strength of radio emissions that are thought to be originating at the heliopause, beyond which is interstellar space; and the distribution of hydrogen within the outer heliosphere.

Orbit: Voyager I at 88 AU from Sun (April 2003), heliographic latitude 34 degrees. Voyager II at 70 A from Sun, heliographic latitude -24 degrees.

Status: Operational. Voyager I launched on September 5, 1977. Voyager II launched on August 20, 1977. Current NASA plan funds operations until at least 2006.

Wind

Agency: NASA (United States)

Website: http://www-spof.gsfc.nasa.gov/istp/wind/

Goals:
- Provide complete plasma, energetic particle, and magnetic field input for magnetospheric and ionospheric studies.
- Determine the magnetospheric output to interplanetary space in the up-stream.
- Investigate basic plasma processes occuring in the near-Earth solar wind.
- Provide baseline ecliptic plane observations to be used in heliospheric latitudes from ULYSSES.

Wind is an element of the the Global Geospace Science Program (GGS) designed to improve greatly the understanding of the flow of energy, mass and momentum in the solar-terrestrial environment with particular emphasis on "geospace". GGS has as its primary scientific objectives: a) Measure the mass, momentum and energy flow and their time variability throughout the solar wind-magnetosphere- ionosphere system that comprises the geospace environment; b) Improve the understanding of plasma processes that control the collective behavior of various components of geospace and trace their cause and effect relationships through the system; c) Assess the importance to the terrestrial environment of variations in energy input to the atmosphere caused by geospace plasma processes. The other GGS missions are Geotail and Polar. Complementary equatorial data are provided by the GOES spacecraft.

<u>Measurements</u>:To obtain the following measurements:

Low-frequency electric waves and low-frequency magnetic fields, from DC to 10 kHz; electron thermal noise, from 4 kHz to 256 kHz, radio waves, from 20 kHz to 14 Mhz; elemental and isotopic abundances for the minor ions making up the solar wind, yielding solar wind velocity, density, temperature and heat flux, electron and ion velocity distributions; abundance, composition and differential energy spectra of solar wind ions, and the composition, charge state and 3-D distribution functions of suprathermal ions; magnetic field; 3-D plasma and energetic particle measurements of ions and electrons in the interplanetary medium with energies including that of the solar wind and the energetic particle range; transient gamma-ray burst events from cosmic gamma-ray sources, and measurements of gamma-ray lines in solar flares;

<u>Orbit</u>: Initially WIND was positioned in a sunward, multiple double-lunar swingby orbit with a maximum apogee of 250Re. Other orbital configurations have been employed to be will be followed by a halo orbit at the Earth-Sun L1 point.

<u>Status</u>: Operational. Launched on November 1, 1994. Current NASA plan funds operations until at least 2007.

AGENCY ACRONYMS AND ABBREVIATIONS

BNSC	British National Space Centre (Great Britain)
CNES	Centre National d'Etudes Spatiales (France)
CNSA	China National Space Administration (Republic of China)
CRCSS	Cooperative Research Centre for Satellite Systems (Australia)
CSA	Canadian Space Agency (Canada)
DOD	Department of Defense (United States)
DRL	Deutschen Zentrum fur Luft- und Raumfahrt (Germany)
EUMETSAT	European Meteorological Satellite Organisation (Europe)
ESA	European Space Agency (Europe)
IKI	Space Research Institute (Russia)
INPE	National Institute for Space Research (Brazil)
IPF	Institute of Applied Physics (Russia)
ISAS	Institute of Space and Astronautical Science (Japan)
IZMIRAN	Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation (Russia)
KARI	Korean Aerospace Research Institute (Republic of Korea)
MEPI	Moscow Engineering Physics Institute (Russia)
NASA	National Aeronautics and Space Administration (United States)
NOAA	National Oceanic and Atmospheric Administration (United States)
NSPO	National Space Program Office (Taiwan)
PPARC	Particle Physics and Astronomy Research Council (Great Britain)
RASA	Russian Aviation and Space Agency (Russia)